POWER

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Let Them Down Easily

DID you ever answer an advertisement "Wanted, an Engineer"?

Perhaps you were out of a job and this appeal of somebody who needed the kind of service that you have to offer, badly enough to advertise that need, was a ray of hope in perhaps a long and discouraging search.

Or perhaps you have outgrown the possibilities of your present situation, or conditions have become unpleasant, and after much hesitation and deliberation you conclude to cut loose from your moorings and seek wider opportunities or more congenial surroundings.

And so you pen the letter the response to which means so much to you—the means of livelihood, the changing of the scene of your activities and the whole course of your life; and then you watch and wait.

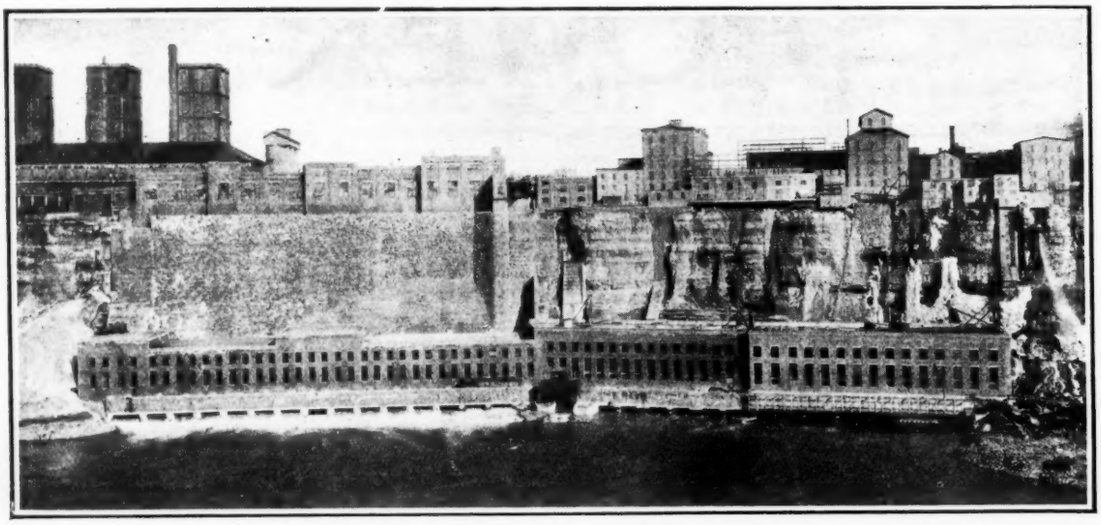
And usually you keep on waiting; for the advertiser, unmindful of the hopes that his offer of opportunity have aroused, unsympathetic to the need for employment, the craving for a chance, of the writers of the letters that his announcement has brought, picks out the most likely of the candidates and scraps the rest of the letters, or at best files them for reference in case of further need.

If he only knew the hopes and ambitions that were behind those letters, the plans and dreams of which they were the base, how anxiously the postman is watched as hope dwindles with successive disappointments!

How little expense and trouble it would be to him to drop a kindly line to each of the unsuccessful candidates, extinguishing hope for this particular job, it is true, but relieving the suspense and bringing the encouragement and satisfaction that one feels when his appeal has received at least respectful notice.

Failure to do this is simple carelessness. The doing of it would be a kindness that would win for its author the thanks and good will of its recipients.

F. R. Low



All water diverted on the American side of the falls is used in this plant†

World's Largest Hydraulic Turbines*

Three 70,000-hp. units installed by The Niagara Falls Power Co. to operate under a net effective head of 213.5 ft. at 107.1 r.p.m. are the highest-powered prime movers yet installed. Each of these machines has carried a load of nearly 84,000 horsepower.

HOW large in capacity power-generating equipment will be built, is open to conjecture, but during the last ten or fifteen years records have been short-lived. In 1919 and 1920 The Niagara Falls Power Co. installed three 37,500-hp. hydro-electric units in its hydraulic station, extension 3-B. These units established a world's record and were masterpieces in hydro-electric engineering. In less than five years after the installation of these machines the company put into operation in its plant, extension 3-C, the first of three machines rated at 70,000 hp., or about double the capacity of those installed in 1919 and 1920. All three of these units are now in commercial operation, and each has carried loads up to about 84,000 hp.

These machines have been designed for the highest commercial efficiency and practically the only limitations placed on the manufacturers were that they produce the best machines possible and that the generating units have the same outside appearance. The generators have a guaranteed efficiency of 98.1 per cent, and tests have shown that these machines come well within their guarantees. Over 88 per cent of the total energy represented by the difference in head between the level in the upper river, where the water is taken out, and the tailrace in the lower river is delivered to the busbars.

It is difficult to get a conception of the great size of these machines, but the accompanying photographs will give some idea of their large dimensions. Fig. 5 shows the bottom of one of the draft-tube chambers. The unit and draft tube bell are supported over this chamber on a reinforced-concrete slab 13 ft. thick, which contains 100 tons of reinforcing bars and 2,000 cu.yd. of concrete. Part of one of the slabs can be seen at the left in the figure, and the top of the slab with the upper end of the draft tube extending through the surface is shown in Fig. 4. The short concrete pedestals are for supporting the turbine casing during assembly, as shown in Figs. 3 and 2. Units Nos. 19 and 20 have sectionalized cast-steel casings, as in Fig. 2, and No. 21 has a riveted plate-steel casing, as in Fig. 11. The cross-sections, Figs. 6 and 7, show more details of the two different constructions. In the following a description of the turbines is given by H. Birchard Taylor, of the Cramp Co., builders of the turbines for units Nos. 19 and 20, and William M. White, of the Allis-Chalmers Co., who built unit No. 21, turbine and generator. The generators for units Nos. 19 and 20 were supplied by the General Electric Company.

Engineering Considerations in 70,000-hp. Hydraulic-Turbine Design

By H. Birchard Taylor*

The turbines for the station 3-C extension of The Niagara Falls Power Company can fairly be considered the most important hydraulic power units ever constructed. Concentrated in the three units comprising this most recent installation of that company is a total rated capacity of 210,000 hp. and a maximum output, based on the full-load capacity shown by actual operation, of an even greater amount. When it is considered

*For a description of the development down to the turbines, see *Power* March 3, 1925.

†The section of the power house on the left (hydraulic plant 3-A) contains thirteen 10,000-hp., the center section (extension 3-B) three 37,500-hp., and the section on the right (extension 3-C) three 70,000-hp. turbines, making a total installed capacity of 452,500-hp. under one roof.

*Vice-President, the William Cramp & Sons Ship & Engine Building Co.; President, the Pelton Water Wheel Co.; and Harper & Taylor, Inc.

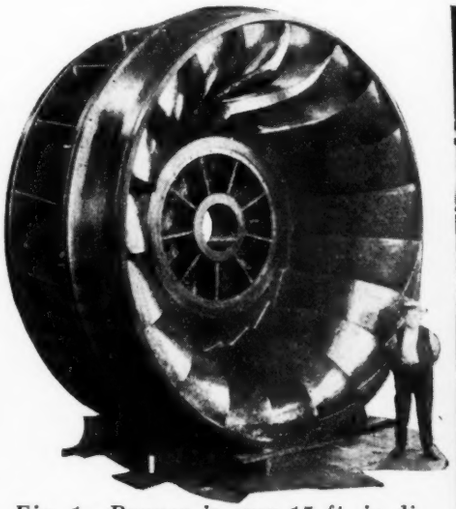


Fig. 1—Runner is over 15 ft. in diameter and weighs 112,000 pounds

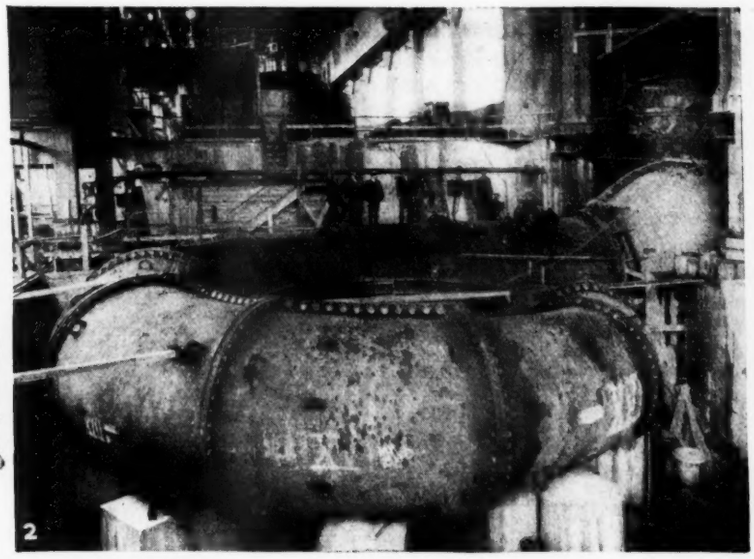


Fig. 2—Sectionalized cast-steel turbine casing for unit No. 19 completely assembled in the plant. Penstock valve on the left

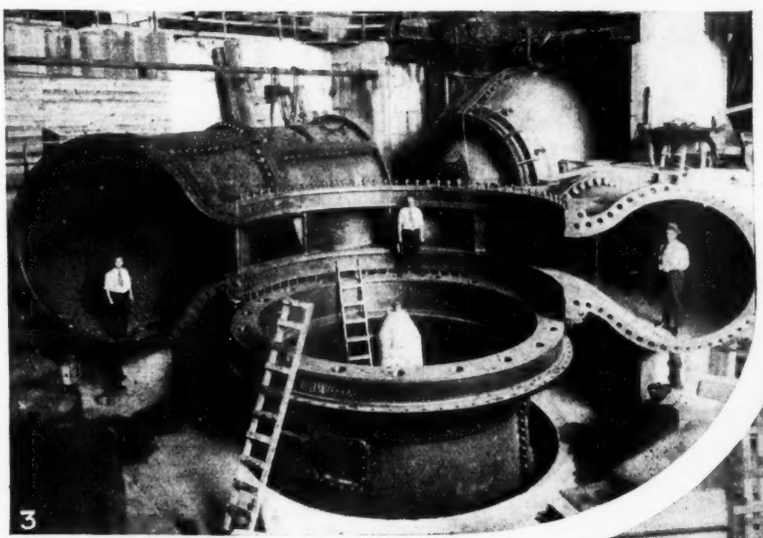


Fig. 3—Shows how turbine casing is assembled around the top end of draft tube

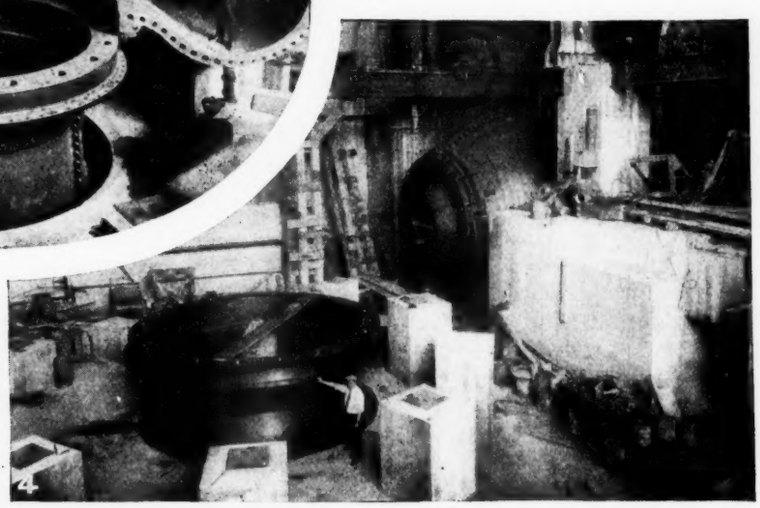


Fig. 4 — Concrete columns spaced around top of draft tube to support turbine casing during assembling

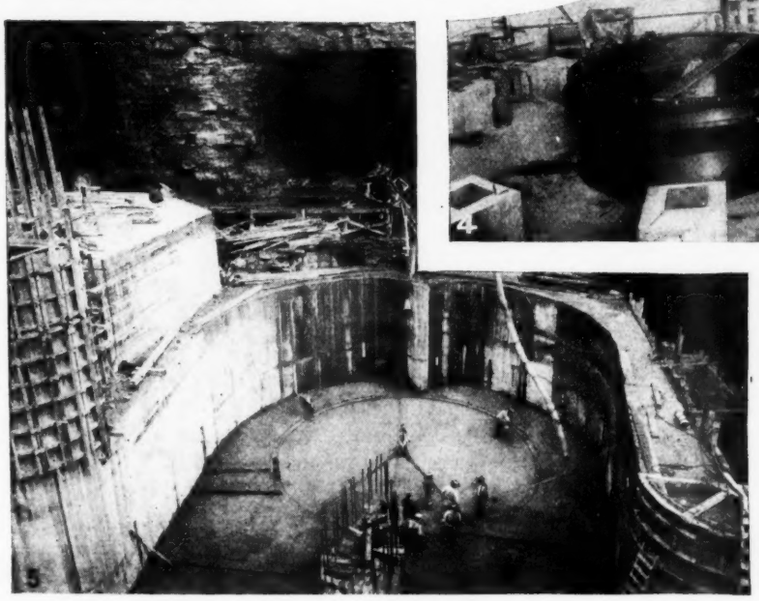


Fig. 5—Bottom of draft-tube chamber

A reinforced concrete slab 13 ft. thick, containing 100 tons of reinforcing bars and 2,000 cu.yd. of concrete supports the unit and draft-tube bell over this chamber.

that the water that can be utilized at Niagara is definitely limited by treaty restrictions, the question of efficiency is seen to be by no means merely academic, but one that governs the actual kilowatt output of the development and therefore its earning power; and it can also be realized that on account of the power capacity that is tied up in these units, questions of

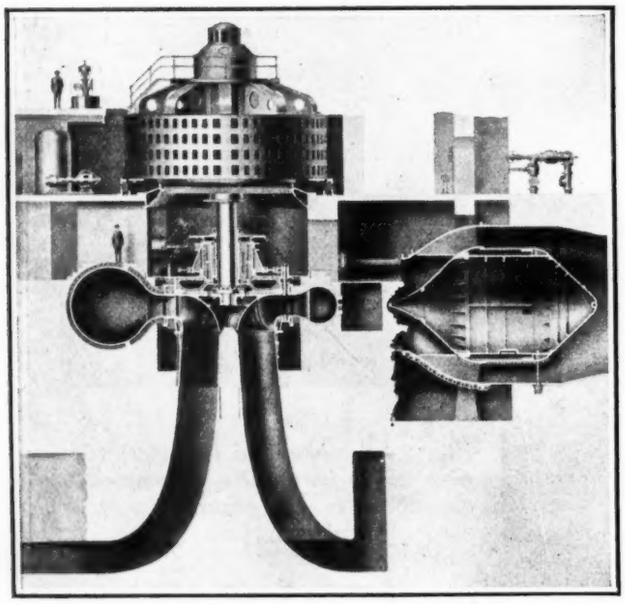


Fig. 6—Section through turbine and penstock valve of units Nos. 19 and 20

dependability, maintenance, regulation, and in fact all the factors entering into turbine design, assume unusual importance.

The units in this station have perhaps been chiefly noted by reason of their size and capacity, but it is believed they are of even greater interest on account of the character of their design than merely on account of their magnitude. The fixing of the size of the units was merely the incidental result of the local space restrictions affecting the arrangement of headworks, penstocks and power house. Prior to and independently of the question of unit capacity, however, engineers of the power company had adopted the fixed policy of securing hydraulic machinery of the highest possible character of design and had aimed at the attainment of the highest possible efficiency.

Opportunity Afforded Turbine Builders

Much of the success of the turbine installation has been due to the unusual opportunity afforded the turbine builders by the power company to demonstrate what could be done in developing and improving the design when unhampered by undue restriction as to first cost or other arbitrary limitations.

The specific speed of the turbines is practically the same as that of the preceding installation of 37,500-hp. units; and the dimensions are increased in such ratio as almost exactly to double the quantity of water and power output of the machines. While the leading dimensions are almost homologous to those of the earlier machines, a comparison of the designs will show many changes. Some of these are due merely to the new conditions introduced by the large dimensions and heavy loads. Others represent a distinct progress in turbine development in the short time between the dates of the two designs.

Fig. 6 is a wash drawing picturing a cross-section through one of the units from which an idea of many of the features can be obtained.

Some of the most marked points of difference between the older and newer designs are the following:

The castings of the two new I. P. Morris turbines on units Nos. 19 and 20, are made up of cast sections, as in the earlier units, but the separate stay-vane ring, or speed ring, has been abandoned in favor of a new method of sectionalizing the casing, developed by the writer. With the increase in dimensions above those involved in the 37,500-hp. units, considerable difficulty would have developed if the separate speed-ring construction had been adhered to. These difficulties lie primarily in the high local stresses and distortion developing at certain points in the structure, notably at the intersection of the radial joints between casing sections and the circumferential joint between speed ring and casing. These effects make it difficult to secure tightness against leakage, and the design of adequate bolting and the provision of proper sections of the casing at these points involve difficulties. The new type of casing avoids these difficulties and results in a simpler and more economical design.

Construction of Casing

The casing, Figs. 2 and 3, is constructed as a series of radial sections including both sections of the casing and speed ring. In the smaller sections of the volute the corresponding portions of casing and speed ring are cast integrally and the stay vanes are made integral with the casing wall. In the larger sections of the casing, where the sizes are such as to require a separation of the stay vanes from the casing wall in order to avoid initial strains and to permit annealing, the inner portion of the casing section containing the stay vane is separated from the outer portion containing the casing wall by plane joints, the two sections being bolted together. After the separate radial sections of casing and speed ring are bolted together, the radial sections are then assembled to form the complete casing and speed ring. Under hydrostatic pressure tests in the shop these casings were found to be tight and free from distortion, and carried the full test pressure of 140 lb. per sq.in. on the first application of pressure. The casings of the 70,000-hp. units also differ from those of the 37,500-hp. machines in respect to material. The earlier casings were of cast iron, while these larger machines required the use of cast steel.

Type of Draft Tube

One of the most striking points of difference between the new I. P. Morris units and the old is the form of draft tube used. The draft tubes, like those of the earlier I. P. Morris units, are of the Moody spreading type, but in the new units the central cone is carried up to the runner, so that the water passage from the runner to the end of the spreading portion forms an annular passage between continuous inner and outer surfaces of revolution. This was the logical development of the conception on which the earlier tubes were based.

It can be demonstrated by calculation that under part-gate conditions in turbines of moderate specific speed, and even under normal-gate conditions in high-

specific-speed turbines, the laws of vortex flow require the formation of a cavity within the flowing stream in the draft tube and along its axis. Even at normal gate there is a strong tendency for a small cavity to form, and at part gate in the earlier forms of draft tube a cavity of considerable extent must exist, this cavity representing a region of turbulence and unstable flow.

The provision of a core of the great height required in these units has been excellently carried out by the engineers of the power company, ample reinforcement within the core being provided to guard against deflection or distortion. A comparatively moderate amount of reinforcement properly distributed was found adequate for the purpose. The effectiveness of this design has been demonstrated both in the units here described and in the somewhat similar 58,000-hp. unit No. 6 in the Queenston plant at Niagara. In both plants the units equipped with the high cones are noticeably quieter in operation than those installed without them. In actual operation the 70,000-hp. units do not develop any degree of noise or vibration such as might be expected in units of this size and head, but have been found to operate smoothly and quietly.

Design of Turbine Runners

The turbines are designed for a rated power of 70,000 hp. when operating under a net effective head of 213.5 ft. at the speed of 107.1 r.p.m. These figures result in a specific speed of 34.7 (foot-pounds) which may be considered a normal value for this head. At this specific speed the chief factors of the runner design are well established and there is nothing unusual in the general proportions of the runners except for their size. It was found possible by a slight adjustment of dimensions to make the runners of the two I. P. Morris units and the Allis-Chalmers unit for this station interchangeable so that a single spare runner can be provided for use in any one of the three units. The runners are provided with labryinth seals to minimize leakage. Each runner is of cast steel in one piece. Many refinements in various details of design have been incorporated in these units, and space restrictions prevent their complete description here. The following features might be mentioned:

The units are provided with adjustable lignum-vitæ bearings for the main turbine steady bearing. This bearing is composed of a series of separately adjustable shoes, each faced with lignum-vitæ bearing strips and adjustable vertically in wedge-shaped channels in the bearing housing. Provision is made for tightening these shoes to prevent vibration after adjustment. Any of the shoes can be replaced without dismantling the other parts of the bearing.

Guide Vanes of the Disk Type

The guide vanes are of the disk type and are of cast steel involving integrally cast circular disks at the top and bottom of each vane to strengthen the vane where the stem joins the vane section. The vane stems are of large diameter and are provided with cast-steel levers arranged in an offset position at an angle to the radial direction, thus providing an operating mechanism having an increased mechanical advantage, or so-called "toggle" action. The vane links act in compression to close the vanes and are designed to fail in shear when stressed beyond a predetermined amount.

The governors are provided with pressure-operated plunger valves controlled by a single lever by means of which the governor may be instantly thrown from hand control to governor control, or vice versa. The governor pressure system is supplied by rotary pumps of the gear type.

The cross-section of the unit, Fig. 6, shows the liberal space provided within the turbine pit for access to the turbine operating gear and bearing, and to the central lubricating system which is provided for the guide-vane bearings. This lubricating system contains a central grease gun operated by compressed air to force the lubricant through permanent pipe connections to each bearing.

To give an idea of some of the dimensions involved in these units, it may be mentioned that the runner is 15 ft. 4½ in. in diameter and weighs about 112,000 lb. The mainshaft is 34 in. in diameter. The total weight of each turbine, including governing mechanism but not including the generator, is approximately 1,250,000 pounds.

Structural Features of Turbine for Unit No. 21

By William M. White*

Unit No. 21, in plant extension 3-C, of The Niagara Falls Power Co., is rated at 70,000 hp. and has developed over 83,000 hp. under operating conditions. It drives a 65,000-kva. 12,000-volt three-phase 25-cycle

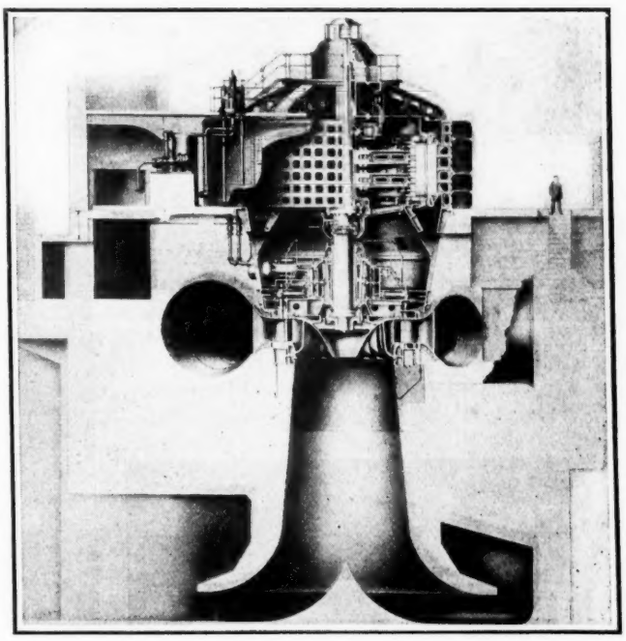


Fig. 7—Section through unit No. 21

generator which was also built by the Allis-Chalmers Manufacturing Co. At the entrance to the turbine a 14-ft. Johnson valve is located, the penstock being flared from the lower side of the valve to 15 ft. diameter to slow the water up before entering the turbine, which is of the vertical plate-steel spiral cased type.

The complete hydraulic turbine, including its governor equipment, weighs over 1,400,000 lb., the revolving parts of the turbine alone weighing over 150,000 lb. The mainshaft is 34 in. in diameter in the bearing,

*Manager and chief engineer, Hydraulic Department, Allis-Chalmers Manufacturing Company.

Fig. 8—Plate-steel casing for turbine of unit No. 21 being riveted with a 108-in. bull riveter during erection in the plant

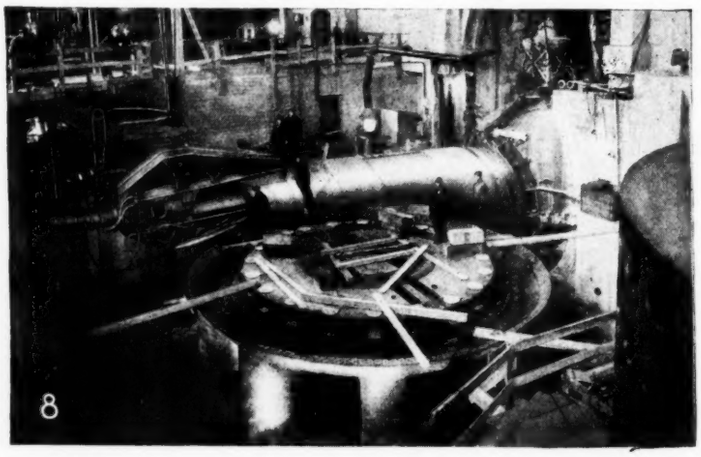


Fig. 9—Assembling casing around speed ring in the shop

The speed ring is made in five sections, held together by heavy bolts and shrink links. It has ten stay vanes which, when the casing is empty, transmit the total weight of the generator and rotating element to the foundation below the casing.

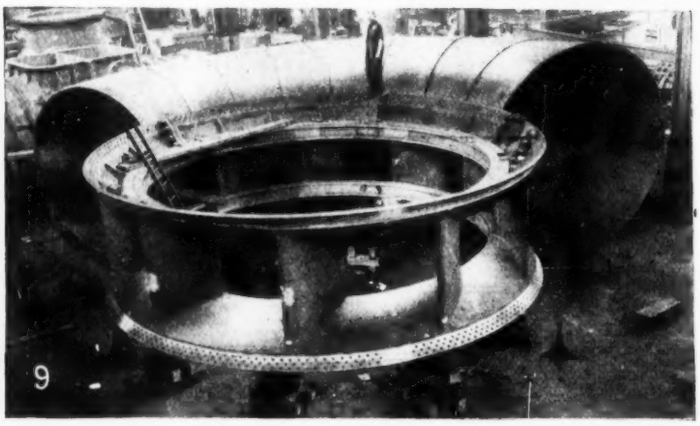


Fig. 10—Pit liner and speed ring assembled in the shop

The generator's stator is mounted on top of the pit liner, and in this way its weight is transmitted through the speed ring to the foundation.

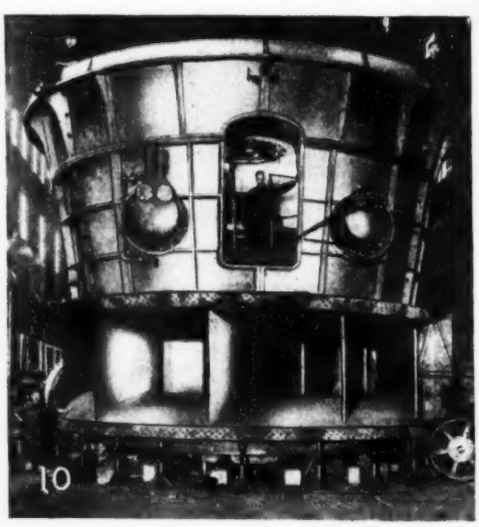


Fig. 11—Plate-steel casing completely assembled

This casing is 15 ft. in diameter at its entrance and about 50 ft. across.

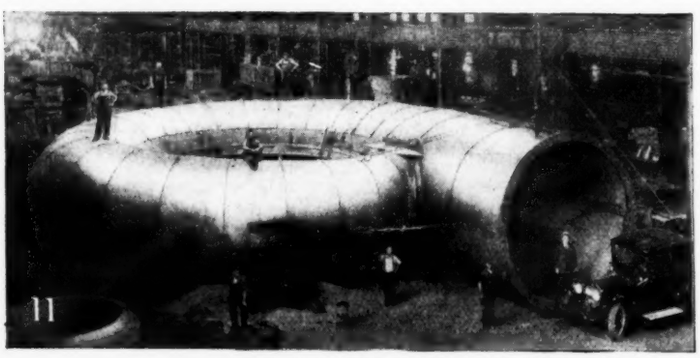
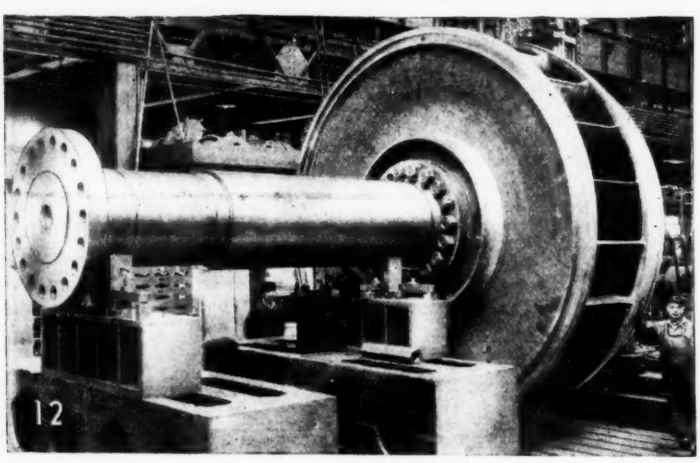


Fig. 12—Turbine runner and shaft

Where the shaft passes through the steady bearing and stuffing box, it is protected by a steel sleeve 105 in. long and 2 in. thick, making a total diameter of shaft in the bearing of 38 in. The shaft is made of a single ingot forged to approximate size.



and the runner has an outside diameter of about 185 in. The plate-steel spiral casing is in effect a continuation of the penstock and measures about 50 ft. across, the plates at the inlet being 1¼ in. thick, reducing to ⅜ in. metal at the small end. The cast-steel speed ring to which the plates are bolted, measures about 25 ft. in diameter and weighs approximately 140,000 pounds.

Fig. 7 shows a section through the complete unit. The water discharges through a concrete hydraucone regainer, developed by the writer and used on one of the three 37,500-hp. units installed in this plant in 1918. The upper part of the hydraucone draft tube just below the runner has a plate-steel liner, which is provided with an inspection manhole for ready access to the lower side of the runner.

Plate Steel Spiral Casing

The plate-steel spiral casing, completely erected in the shop, before shipping, is shown in Fig. 11. The construction of a plate-steel casing of this size and type is an interesting engineering problem. Each plate is first laid out to size and shape, and all the rivet holes are punched. The plate is next rolled and each section is then fitted into its proper place and temporarily bolted together. Starting about halfway around the casing, the plates are bolted up to the speed ring as in Fig. 9, then the casing is continued in both directions around to the inlet, which is the last part to be assembled. The various plates are held together by bolts put through the rivet holes 10 to 12 in. apart. When all the plates are in place and properly fitted, all the rivet holes are reamed to proper size, after which the plates are numbered and match marked so that they can be assembled readily during erection in the field.

How the casing was erected and riveted in the field, using the 108-in. bull riveter especially designed for this purpose, is shown in Fig. 8. The precision with which these plates are fabricated and fitted has been demonstrated in the casings for the 45,000-hp. Isle Maligne turbines, which are larger than the Niagara Falls casing and were assembled in less than two days each and completely riveted and calked in seven days.

The speed ring is made in five sections and is held together with heavy bolts and shrink links. There are ten stay vanes in the speed ring, which, when the casing is filled with water, stands the internal strain due to the water pressure, and when the casing is empty, the entire weight of the generator and parts above the center line is transmitted to the foundation through them. The outlines and shape of the stay vanes can be seen in Figs. 9 and 10, the stay vanes being flared slightly where they connect into the upper and lower flange in order to give added strength and stiffening.

The mainshaft of this unit is 34 in. in diameter and about 18 ft. long. The flange on the upper end where it is connected to the generator shaft is about 58 in. in diameter, this shaft being made from a single ingot of steel forged down to the approximate dimensions. Where the shaft passes through the steady bearing and stuffing boxes, it is protected with a steel sleeve about 105 in. long. The walls of this sleeve are 2 in. thick, making a 38-in. diameter bearing surface.

The main steady-bearing which holds the shaft, is of the adjustable water-lubricated lignum-vitæ type and consists of six adjustable bearing shoes, each shoe being lined with lignum-vitæ strips which are bored out to give a true bearing surface. These bearing shoes are tapered on the back side, and by drawing them down lower into the bearing housing, the diameter is decreased so that the bearings may be adjusted to take up any wear. Water is forced in just above the bearing surface so that the bearing is continually flooded at all times, and provision is made so that grease may be forced into the bearing to assist in lubricating. Provision has been made for clear water to lubricate these bearings from a large settling basin on top of the cliff, so that any sand or foreign matter may be taken out before it enters the bearings.

The runner, Fig. 12, is 15½ ft. in diameter and is made of cast steel weighing approximately 100,000 lb. and is attached to a flange forged on the lower end of the mainshaft with taper bolts so that it is readily removable. The runner is modeled exactly after a 20-in. diameter runner which, in the Holyoke testing flume, showed over 92 per cent efficiency.

The cast-steel guide vanes, of which there are twenty, weigh about 2,300 lb. each and have an over-all height of about 8 ft. The design of the cover plate on unit No. 21 is so arranged that each guide vane has three bearings—one directly below the water passage, one directly above and a third, or outboard, bearing just below the guide-vane lever. An adjustable stuffing box is located between the two upper bearings. This construction is desirable with a turbine operating under the head on this unit in order to prevent water leaking along the guide-vane stems into the turbine pit. The weight of the guide vanes is carried on a thrust bearing above the third, or outboard, upper bearing. The position of the guide-vane lever on the stem is adjustable so that the vane may be centered exactly in the water passage and does not rub on the top or bottom of the guide case.

Breaking Links Used to Connect Guide-Vane Levers to Shifting Ring

Short breaking links are used to connect the inner end of the guide-vane levers to the shifting ring. These links are constructed with a shearing section so that they break either under tension or compression in case some obstruction lodges in the guide-vane passages. This construction with long operating levers and short breaking links, also has an advantage in that in case of breakage of several links, the guide vanes are not free to rotate, as the extended ends of the levers strike the adjacent guide-vane stems. This will allow a maximum travel of only about 120 deg. and prevent the large end of the guide vane from entering the runner.

The governor that controls the speed of this unit is not radically different from that on the 37,500-hp. unit, although it has a capacity of 300,000 ft.-lb. at 200-lb. oil pressure, being supplied with two 120 gal. per min. 200-lb. rotary gear type pumps. The governor-control stand is mounted on the generator floor and contains all the controls, synchronizing motors and load-limit attachments for starting up, shutting down or adjusting the speed of the unit. The flyballs are of the direct-connected type, developed by the writer and are mounted on the mainshaft just below the generator coupling. This construction had been used on turbines aggregating upward of 1,375,000 hp. The cylinders that control the position of the guide vanes and shifting ring, are bolted to the supporting barrel, which extends upward from the speed ring and carries the weight of the generator. Fig. 10 shows the unit assembled in the shop with the speed ring and supporting barrel, showing the rear view of these two cylinders in place.

Direct-Current Motors Fail to Start—General Considerations

TELLS how to diagnose the source of trouble by what happens at the starting box when an attempt is made to start the motor

By B. A. BRIGGS

FAULTS in direct-current motors may be divided into two classes—those that cause the motor to fail to start, and those where the motor starts but develops conditions that make it impossible or undesirable to operate the machine. When a machine is being put into service for the first time, faults can occur that cannot develop after the machine has been in satisfactory operation.

Assuming that the motor has been in satisfactory operation and that it fails to start after being shut down; further assume that the machine is compound wound and connected to a manual type of starting box as in Fig. 1. What happens when the arm is brought up on the first contact of the starting box and allowed to drop back to the off position tells a lot about where the trouble may be. There are three things that can occur: First, the arm can break the circuit with the contact without obtaining a spark, in which case it is a pretty good indication that the trouble is somewhere in the line back of the starting box. For example, the power may be off the line, one of the fuses may be blown or making poor contact, or there may be a loose connection at the switch or some of the conductors may be open.

The second condition that may exist at the starting box when the arm leaves the first contact is a vicious spark; this spark giving the action of a small current

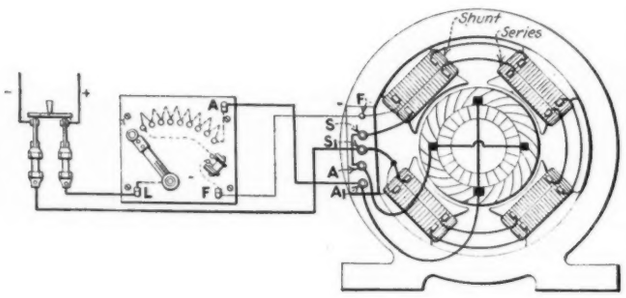


Fig. 1—Diagram of connections for a compound-wound motor with starting box

at high voltage. In such a case the indications are that the field circuit is closed and the armature circuit is open. This can be checked by disconnecting the armature connection at the starting box, as in Fig. 2, and bringing the arm upon the first contact again. If, when the arm is allowed to drop back, a spark is obtained as before, it shows that the armature circuit is open and the field closed.

The third effect that may be obtained when the arm is allowed to fall back off the first contact, is a heavy spark as if the large current were interrupted. This is an indication that the armature circuit is closed and the field circuit is open somewhere, although this is not necessarily the case. To test if the field is open, disconnect the armature wire at the starting box, then close the switch and place the starting-box arm on the first contact, after which it is allowed to fall back to the off position. If the field circuit is open, no spark

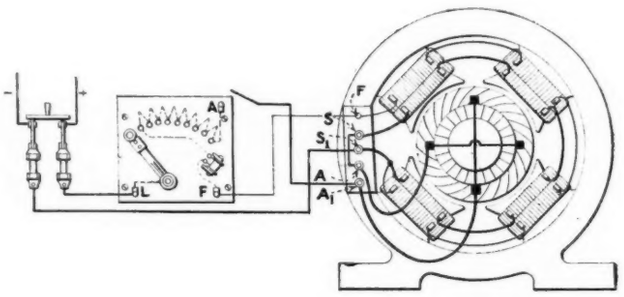


Fig. 2—Armature circuit open to test if field circuit is complete

will occur when the arm breaks contact. Should a sharp intense spark occur, it would show that the field circuit is closed and the motor's taking a large current and not starting is due to some other cause.

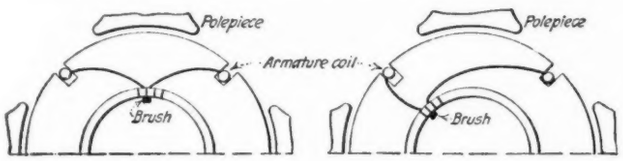
Where a motor fails to start, one of the first things to determine is that the load can be started. One case in mind is that of a motor driving a pump. After an electrician had worked all day trying to get the motor to start, the writer was called in to try to locate the trouble. One of the first things attempted was turning the pump over by a pull on the large gear wheel, with the discovery that it could not be turned. The discharge pipe to the roof tank was frozen up. Closing the suction valve and opening a drain plug relieved the pump so that it was free to be driven by the motor. This case is not exceptional for it is not uncommon for an attendant and others to try to make a motor start a load that cannot be moved without breaking something. Therefore, if any difficulty is experienced in getting a motor to start its load, one of the first things to ascertain is whether the load can be moved, which can be tried by hand. The trouble may not be in the load, as the motor's bearings may have run dry and seized the shaft, in which case it is likely that the fuses would blow or the circuit breaker open.

Another cause of the motor's being unable to start its load, or even to start without load, is the brushes off the neutral. If the brushes are shifted off the neutral by about one-half a pole space, the motor will be unable to start even without load. Movement of the brushes a few segments back of the neutral will cause an increase in speed, generally accompanied by severe sparking. Shifting of the brushes a few segments

ahead of the neutral will cause a reduction in speed, accompanied by severe sparking.

In modern machines the correct position of the brushes is usually marked. If this position is not marked on the brush yoke and bearing, it generally can be checked by seeing if the brushes line up with the center of the polepieces or the center of the space between the poles. In modern machines the correct position of the brushes is usually opposite the center of the polepieces, as in Fig. 3. On some machines the position of the brushes is opposite the center of the space between the polepieces, as in Fig. 4.

A further check of the brush position can be made by starting from a coil side in a slot in the center of the neutral zone and tracing the top lead to a commutator bar. This bar should be close to the correct brush position. If the machine has interpoles, as in Fig. 5, then a coil under the center of an interpole should connect to a segment under the brushes on one stud. This, however, does not indicate that the brushes are set up in the correct position, but are close enough to this position not to interfere with the starting of the motor. The correct position of the brushes can be determined in a number of ways, but these will not be dealt with at this time.



Figs. 3 and 4—Show correct brush positions

If the motor is compound wound, the series- and shunt-field coils in opposition may cause the motor to fail to start under one set of conditions and allow it to come up to speed under other conditions. The series- and shunt-field coils with opposite polarity may also produce a number of other effects:

1. The motor may fail to start. Under this condition the armature usually makes a slight effort to turn first in one direction and then in the other.
2. If the series coils are of the correct proportions, they will have the effect of giving the motor a constant speed from no load to full load, such as the conditions found in motors designed for differential connection of the field windings.
3. Under no load, the motor may start and operate satisfactorily, but when load is applied it may race, spark badly at the brushes and cause the protective device to open.
4. After being started and load applied, the motor may decrease in speed to where the protective devices will open. This is usually accompanied by severe sparking at the brushes or a complete flash-over on the commutator. If the motor is of small capacity and is not properly protected, it may stop, reverse and run in the opposite direction.

Where an armature has been badly short-circuited, it may fail to start, or if it does it will have a jerky motion and will turn at a very slow speed. In small two-pole machines the armature may become open-circuited in such a way as to cause the motor to fail to start, but in such a case there will be no current flowing in the armature circuit. On such machines the brushes may stick in the holders so as not to make contact with the commutator, and thus prevent the motor from starting.

When the frame of the machine and one side of the line are grounded, a ground in the armature or series field winding if the motor is compound wound may cause the machine not to start. A large current will flow through the starting device and cause the protective devices to open if the starter arm is moved over across the contacts toward the on position. As the resistance is cut out, unless the motor is properly protected, the current may become high enough to burn out the last two or three sections of the resistance, if an attempt is made to move the starting arm to the full-on position. If the starting arm is allowed to remain on the first contact for any length of time, the starting resistance will become hot and begin to smoke. The foregoing would be the case for any condition that would cause the motor to fail to start with a current flowing through the armature.

If the equipment is new and going into operation for the first time, it is advisable to check the starting-box connections, since the shunt-field connection may be made within the box so as to prevent the field coils' being excited. In one case in mind, of a shunt motor where the starting box was repaired and put back into service, the motor failed to start. Opening the armature connection at the starting box, as in Fig. 2, bringing the arm upon the first contact and letting it drop back to the off position, showed the field circuit to be complete. The field connection was then opened and the armature circuit closed at the starter, the switch was closed and the test repeated, which showed that the armature circuit was complete.

As the motor had been operating satisfactorily before the starter was taken out for repairs, it was decided to investigate the connections in the starting box before looking further for the trouble. On opening the starting box, it was found that the field connection had been made to the armature end of the starting resistance, as in Fig. 6, instead of to the line end, as in Fig. 5. This connected the field winding directly across the armature. On account of the low resistance of the armature compared to that of the field coils, nearly all the current that passed through the starting resistance went through the armature circuit, leaving the field coils practically dead, so that the motor could not start. The remedy for the trouble was to correct the field circuit on the line end of the resistance as in Fig. 5. With the connection, Fig. 5, when the arm of the starting box is brought on to the first contact, the field winding is connected directly to the line, and

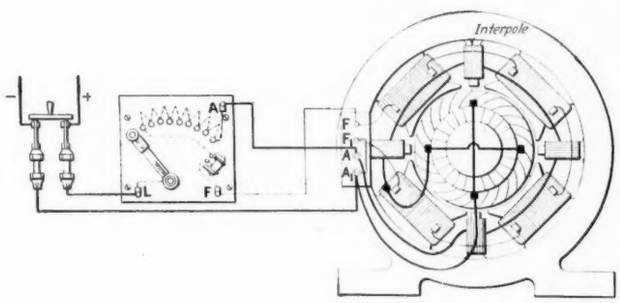


Fig. 5—Diagram of connections for a shunt-interpole motor with starting box

only the armature is connected in series with the starting resistance.

It should be mentioned that an open field circuit, or making the field connections in the starting box as in Fig. 6, does not necessarily cause a shunt motor to fail to start except where the motor is loaded or the brushes are set on the neutral. When the motor is starting without load and the field circuit is dead, if the brushes are set back of the neutral it will start backward. With the brushes shifted ahead of the neutral, rotation will

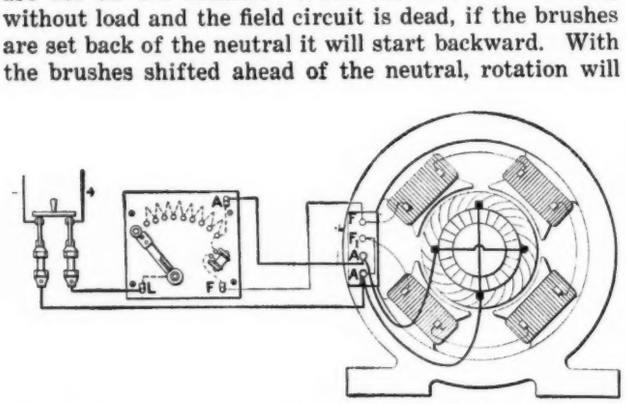


Fig. 6—Shows incorrect field connection in starting box

be in the normal direction. With the field circuit open this will be accompanied by excessive speed and bad sparking at the brushes. If the field connections are made in the starting box, as in Fig. 6, the motor will start and come up to speed with a forward shift of the brushes. Shifting of the brushes causes the armature to magnetize the field poles sufficiently to produce a torque that will start the motor under light-load conditions. After the armature starts to revolve, the counter-electromotive force builds up and increases the voltage across the armature to which the field coils are connected and causes the current to increase in these coils. This increases the field strength and the motor comes up to speed as the starting resistance is cut out. If the brushes are set back of the neutral, the action of the field coils would be to prevent a backward rotation and the motor would not start in either direction.

Where the motor is compound wound and the series-field coils are of the correct polarity, the motor should start under almost any condition with the starting box connected as in Fig. 6. If the shunt-field circuit is open, the motor will race unless heavily loaded. Where the field connection is made in the starting box, as in Fig. 6, the motor will have a tendency to start slowly at first and then pick up speed rapidly as the shunt-field current builds up in the coils.

There are a number of conditions that will prevent power from passing through the motor and cause it to fail to start. These will be made the subject of another article.

Since most disconnect switches are of the single-pole separately operated type, one loaded disconnector is sometimes safely opened, the load being then carried by the other two. By first opening the disconnector a short distance, any indication of power current can be noted, and when only one phase has been opened, the disconnector can generally be safely returned to the closed position. It is highly important that a disconnector never be opened with one quick movement, for, should it be carrying load, a loss of property and life would probably ensue, due to the resulting arc.

Steam Piping for Kearny Station

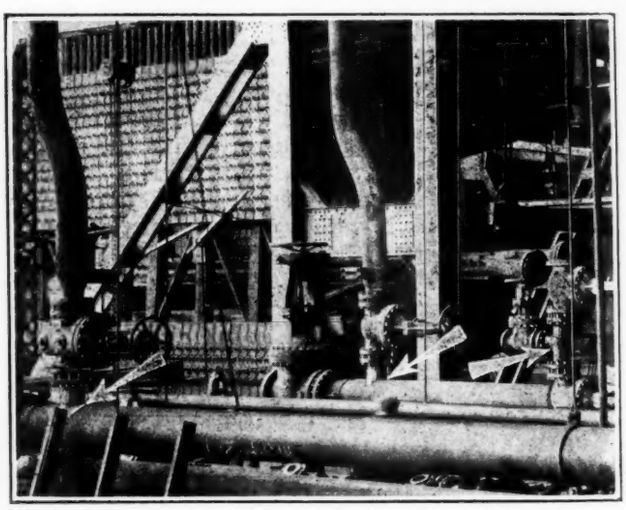
By H. L. R. Whitney*

The high-pressure steam and boiler-feed piping at the Kearny (N. J.) Station of the Public Service Power Co. is believed to be unique in several respects. It is the first of the large high-pressure installations in which the proposed American Engineering Standards Committee 400 lb. Working Steam Pressure Steel Standards were used, and of the recent large stations it is the first where forge-welded construction is installed wherever possible with a view to eliminating fittings and joints. Also the materials and fabrication for the piping job were inspected by a boiler insurance company, for which an insurance policy and inspection certificate were issued.

The operating steam pressure is 360 lb. per sq.in. at the boilers, and the total operating temperature is 720 deg. F. The Sargol patented joint was decided on for all high-pressure steam and boiler-feed piping 4-in. and larger, chrome-nickel steel studs being used for the bolting material.

Two types of piping design were considered as practicable for this work: First, cast-steel fittings and lap-welded pipe, using the longest available mill lengths of pipe; second, forge-and-hammer lap-welded nozzles, or outlets, and forge-hammer lap-welded end welds in the pipe, all possible joints to be eliminated.

The forge-welded design, built in accordance with the A.S.M.E. Code for Unfired Pressure Vessels and in-



Outlets for vertical pipes (indicated by arrows) are welded to larger horizontal headers, thus eliminating standard bolted reducing fittings

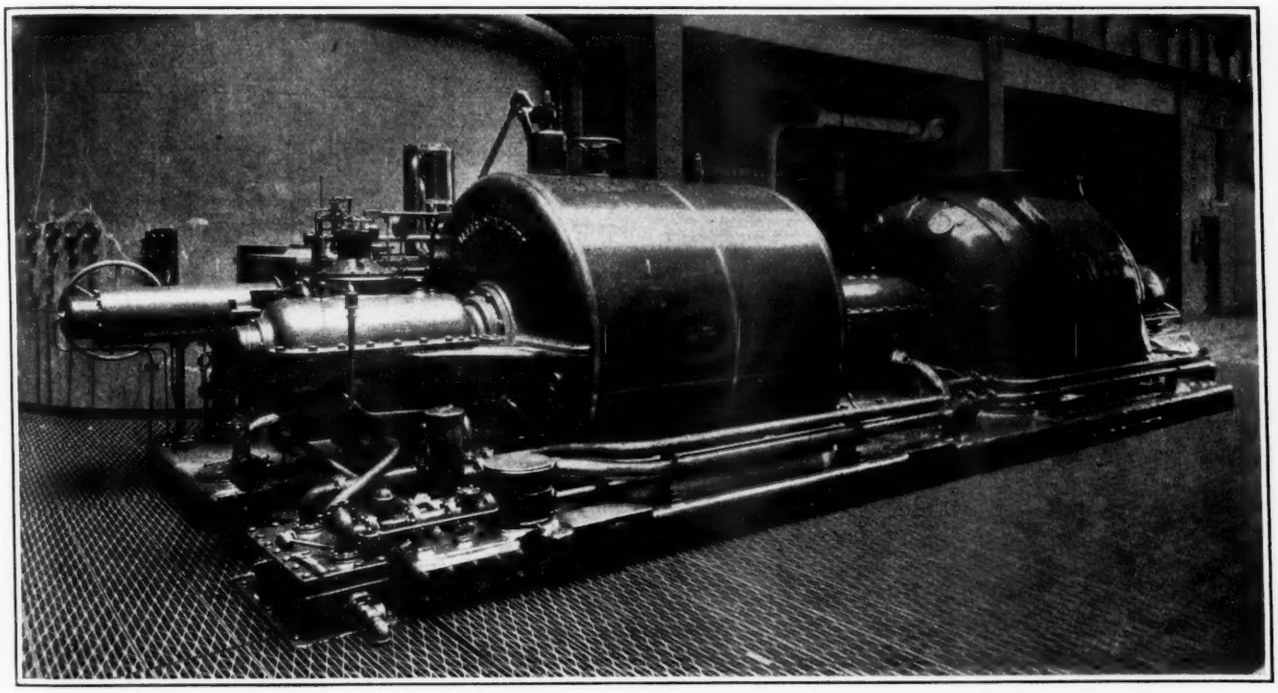
spected and insured by the Hartford Steam Boiler Inspection & Insurance Co., was utilized. The gain by forge-welded construction for these piping systems, by eliminating 39.5 per cent of the joints, may be summarized as: (A) Field welding, or autogenous sealing, and royalty on patented joints; (B) the bolting up of 39.5 per cent fewer joints, the handling of 52 per cent fewer pieces and 15 per cent decrease in weight; (C) 39.5 per cent less bolting material; and (D) 39.5 per cent less insulating flange covers. The engineering was handled by the Public Service Production Co., Newark, N. J.

*The M. W. Kellogg Company.

High Back-Pressure Turbine

A NON-CONDENSING turbine exhausting steam at 100 lb. pressure is operating satisfactorily in the plant of the B. F. Goodrich Co. at Akron, Ohio. The installation is unusual on account of the size of the turbine and the steam conditions under which it operates.

Prior to the installation of the turbine boilers had been installed which were designed for 250 lb. pressure but were being operated at a gage pressure of 150 lb. Almost all the steam used could have been supplied from the boiler plant at 100 lb. pressure. The steam demand was great enough to make it evident that a considerable amount of electrical energy could be generated by a district. The turbine is tied in electrically with a system served by the Windsor and Philo stations of the American Gas & Electric Co., the local station of the Northern Ohio Traction & Light Co., and the power stations of the Cleveland Electric Illuminating Co. The demand of the Goodrich company exceeds the output of the turbine. No difficulty has been experienced on account of the connection of the unit to the network. The electric energy not generated by the turbine is automatically supplied by the other generating stations. The power factor of the Goodrich load carried by the high-tension lines is improved by over-excitation of the Goodrich turbo-generator. The amount of this power-



Five thousand kilowatt turbo-generator taking steam at 250 pounds and exhausting at 100 pounds

turbine operating on steam pressures between 250 and 100 lb. The result has been the design and installation of a special turbine. The turbine is designed to take steam at 250 lb. gage pressure and exhaust steam at 100 lb. gage, generating 5,000 kw., with a heat depletion of approximately 4 per cent. Superheated steam is supplied to the turbine, and the steam leaving the turbine is in a superheated condition. Superheat throughout the entire cycle of expansion results in higher efficiency than where the steam is in a saturated condition for a large part of the cycle, as the wet steam gives rise to friction losses in the turbine.

A special governing mechanism regulates the flow of steam to maintain the desired exhaust pressure. The electric energy generated varies in accordance with the amount of steam passing through the turbine, and this energy is delivered to the main substation bus, where it is distributed with electric energy secured through connection to the high-tension network serving the factor improvement increases as the steam passing through the turbine decreases.

A difficult problem in connection with the design was the selection of satisfactory reducing valves which would supply steam at the reduced pressure required on the low-pressure side of the turbine at times when the turbine might be taken off the line or for any momentary period when a disturbance would interfere with the proper regulation of the exhaust steam pressure by the turbine governor. Satisfactory reducing valves involving air operation have been in service and the problem has been solved successfully.

Inasmuch as the heat depletion in the use of steam in the manner just described is low and the cost of the installation does not involve a condenser and auxiliaries, it is apparent that the cost per kilowatt-hour of electric energy generated is exceptionally low. The vulcanizers and other heat-using equipment throughout the factory take the place of the condensers

in a power plant, so that the large loss ordinarily found in the heat balance of a power plant, after the steam has left the turbine, is absent in this cycle of operation. The turbine may be considered a reducing valve in which the steam expanding to a lower pressure generates efficiently electric energy. A turbine operating under steam conditions such as exist in the case of the Goodrich machine will generate electric energy at a lower cost than central-station power. The range of application of high back-pressure turbines has been extended greatly by the advancement made in recent years in the design of boilers for high operating pressures.

The installation of the high back-pressure turbine was planned by B. H. Clingerman, consulting engineer of the B. F. Goodrich Co. The turbine was designed and built by the Allis-Chalmers Manufacturing Company.

Practical Measurements in Slide-Valve Setting

BY A. J. NICHOLAS

Two methods may be used in connection with the setting of a slide valve. A valve diagram may be drawn and the main characteristics determined before actually setting the valve. This is essentially a drawing-board problem of fairly high degree of accuracy. Again, the valve may be set by a cut-and-try method for some assumed condition either of equal cutoff or equal lead. This is a simple procedure and probably the one most used in practice. In this connection, however, several interesting practical measurements can be taken as a check on the first method, should one then care to draw the Zeuner, Bilgram, or Sweet valve diagrams for further study of the setting.

It will be found that the following measurements will be of use in the connection. The accompanying sketch shows a valve at the mid-position of its travel. Before the valve is set, it is an easy matter to measure the dimensions x, y and A, also the valve travel m (measured from the valve-stem travel). The seat dimensions P, P_1 and B can readily be measured when the valve is removed.

With the valve set for either equal lead or equal cutoff, the maximum port openings at both ends of the valve can be measured. It is well known that half the valve travel is equal to the steam lap plus maximum port opening (*m.p.o.*) for a given end. Set up in a form of an equation, this gives

$$\frac{m}{2} = S + m.p.o. \text{ [Head End]} \qquad (1)$$

and

$$\frac{m}{2} = S_1 + m.p.o. \text{ [Crank End]} \qquad (2)$$

from which the steam laps S and S_1 can be calculated. From the drawing it is evident that

$$x = S + P + e \qquad (3)$$

and

$$y = S_1 + P_1 + e_1 \qquad (4)$$

By substituting the values of S and S_1 calculated from equations (1) and (2) in equations (3) and (4), the values for the exhaust laps e and e_1 can be found. It is also evident that

$$A - B = S + S_1 \qquad (5)$$

This is an excellent independent check on the calculated valves of the steam laps S and S_1 as found from equations (1) and (2).

To illustrate better the application of the foregoing, the following data were taken on a 4¼x5-in. Toomey vertical engine in the mechanical engineering laboratory of the Pennsylvania State College. This valve was set by the cut-and-try method, as mentioned, for ¾ equal cutoff. The measured data were as follows:

Valve travel (m) = 1¼ in.
x = ¾ in.
y = 33/32 in.
A = 2⅝ in.
B = 2¼ in.
$P = P_1$ = ⅜ in.
Maximum port opening, head end = 25/32 in.
Maximum port opening, crank end = 11/32 in.

Using equations (1) and (2), the steam laps S and S_1 are calculated to be 11/32 in. and 25/32 in. respectively.

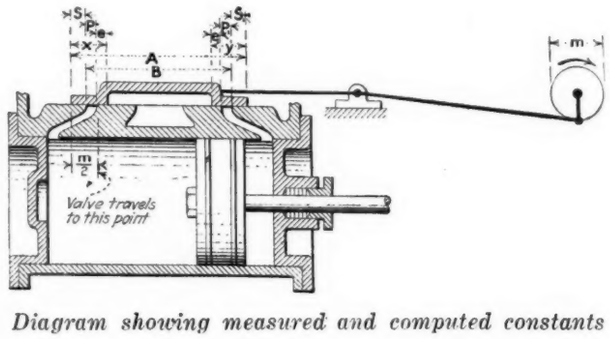
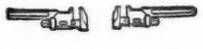


Diagram showing measured and computed constants

Using equations (3) and (4), the exhaust laps e and e_1 are calculated to be 3/32 in. and 1/16 in. respectively. Using equation (5), the difference

$$A - B = \frac{5}{8} \text{ in.} = S + S_1.$$

This difference checks with the values of S and S_1 calculated from equations (1) and (2). The foregoing calculated values checked very closely with the Bilgram diagram values for the setting given. Also the indicator diagram for the setting was a good one. It is evident, therefore, that from a few simple, practical measurements for a given valve setting, the main characteristics can be easily calculated.



It is foolish to buy a steam trap by the pipe size with no thought as to the quantity of water to be handled. Capacity tests of various makes of inch-and-a-quarter traps at the Naval Engineering Experiment Station, with 250 lb. pressure, showed a variation in capacity from 2,300 to 26,000 lb. per hour. In other words, some of the traps had over ten times the capacity of others with the same size of pipe connection. The discharge under a given pressure is determined, not by the pipe size, but by the area of the orifice, which is quite a different matter. When steam is on the line or piece of apparatus, the simplest way to find the amount of condensation is to measure it directly, using a graduated measure or bucket and scales.

In collecting flue gas samples over water for analysis, care should be taken that the water is saturated with gas before the final sample is drawn. Otherwise the CO_2 will be reduced appreciably by absorption in the water.

Engineering Analysis Characterizes Hudson Avenue Operation*

By E. C. M. STAHL
Field Engineer, Brooklyn Edison Company

OPERATING schedule of Brooklyn superstation permits loss of largest unit, at any time, without loss of load. Starting sequence planned for best economy. Boiler-room bonus system based on perfection with which steam and air flow are kept in constant ratio. Special charts shown for computing flue loss and boiler efficiency as part of daily routine.

THE Brooklyn Edison system consists of three generating stations: The Hudson Avenue Station of 150,000-kw. capacity; the Sixty-sixth Street Station of 65,000-kw. capacity (both 60-cycle stations); and Gold Street, a 25-cycle station of 125,000-kw. capacity, giving a total of 340,000-kw. capacity. Hudson Avenue is the base-load station and will be operated as such.

In order to provide absolutely continuous service from our stations, it is our operating policy always to have sufficient generating capacity in operation so that in the case of the loss of the largest unit, the other units in operation will be able to pick up the entire system load. This principle is carried right through to the boiler room and essential auxiliaries, and it is also used in the substations.

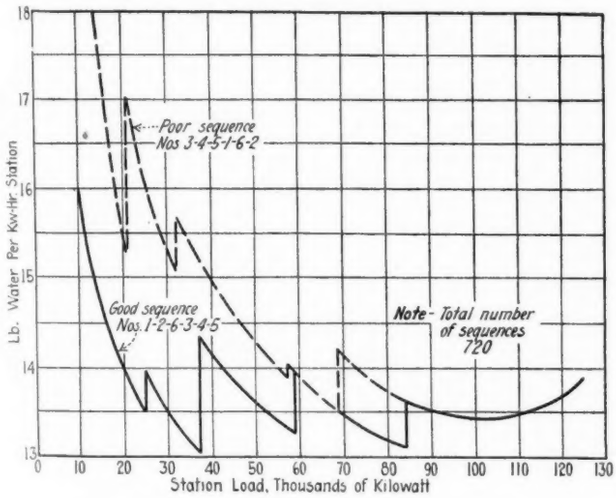

Lb. Water Per Kw-Hr. Station
Station Load, Thousands of Kilowatt
Poor sequence Nos 3-4-5-1-6-2
Good sequence Nos. 1-2-6-3-4-5
Note- Total number of sequences 720

Fig. 1—Best and worst sequence in starting up

With six machines having different water rates there are 52 operating combinations and 720 possible sequences of arriving at these combinations.

In addition to the system schedules each generating station is furnished with a carefully developed set of schedules for directing the operation of all equipment at various station loads and combinations of generators. Each boiler is equipped with an individual boiler panel designed to give the attendants complete information as to the momentary condition of the fires and combustion and also to make a record of the boiler's daily performance.

The steam-flow air-flow meters are set so that at all ratings the red and blue pens should be together with about 30 per cent excess air, which gives approximately 14 per cent of CO_2, corresponding to the proper combustion conditions. At the present time the stokers are operated entirely by the stokermen, only the forced draft pressure being regulated from the combustion-control room.

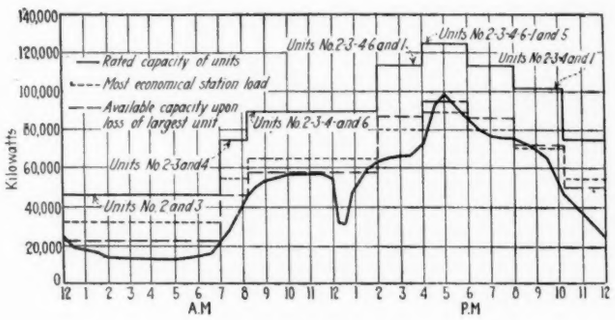

Kilowatts
Rated capacity of units
Most economical station load
Available capacity upon loss of largest unit
Units No 2-3-4-6 and 1
Units No 2-3-4-6-1 and 5
Units No 2-3-4 and 1
Units No 2-3-4 and 6
Units No 2-3 and 4
Units No 2 and 3
A.M
P.M

Fig. 2—Showing how available capacity is always kept above the load by an amount equal to the capacity of the largest unit connected

In order to correct combustion conditions and incidentally to create a friendly spirit of rivalry, the stoker attendants on the three watches are given a rating based on the success with which they keep the red and blue lines together. These ratings are posted on the bulletin board, and on noting the consistent improvement in rating made by one of the stokermen, which went from 90 to 95 and then to 100 per cent, one of the boilermen remarked to the stokerman, "Tomorrow you make 105!"

The boiler-control room is laid out in order to provide a centralized control for each group of eight boilers and in turn for the control of all four groups. In order to accomplish this, automatic load indicators have been provided for each group of eight boilers and for the whole station.

The Ward Leonard control for the forced-draft fans and stokers is centralized in this room together with the necessary steam-pressure gages, stoker speed indicators, forced-draft pressure gages, etc. The basic means of control is then to set the group stoker speed to correspond to the load on the number of boilers in operation and adjust the draft to maintain steam pressure.

*Some of the high lights of a paper presented before the Metropolitan Section of the A.S.M.E., Jan. 21, 1925.

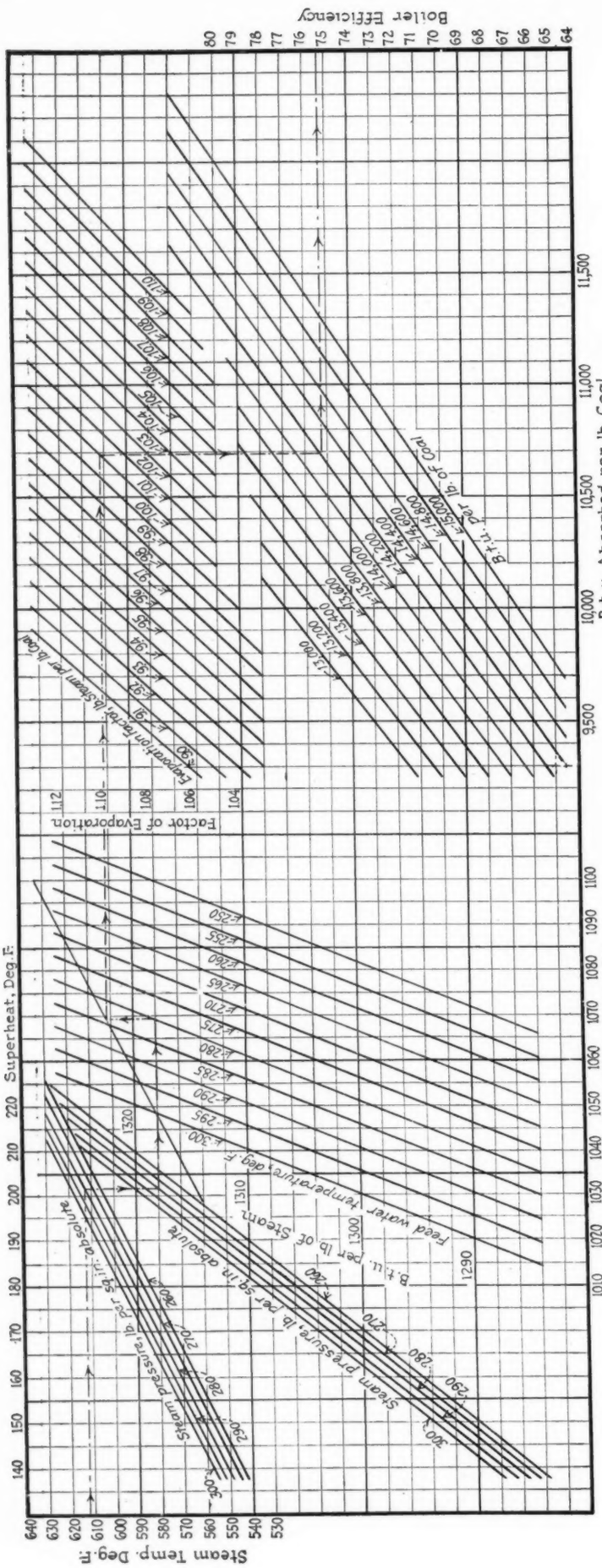

Boiler Efficiency
Steam Temp. Deg. F.
Superheat, Deg. F.
Factor of Evaporation
Evaporation factor, lb. steam per lb. coal
Steam pressure, lb. per sq. in. absolute
Feed water temperature deg. F.
B.t.u. per lb. of Steam
B.t.u. Absorbed by Boiler per lb. Steam.
B.t.u. Absorbed per lb. Coal
B.t.u. per lb. of Coal

Fig. 3—Chart for rapid determination of boiler efficiency over the range of conditions encountered at Hudson Avenue station

As has been previously pointed out, some manipulation at the individual boilers may be done in order to keep the fires in proper condition and give the very best combustion.

Just opposite the boiler-control panel is a panel having the temperature recorders and other instruments necessary for checking conditions at various points in the heat balance. The majority of the instruments are remote indicating temperature recorders.

Charts for Efficiency and Flue Loss

Data in the form of curves and tabulations have been worked up to show the proper readings of all indicating and recording instruments under various conditions of station load and combinations of units. All that is necessary in order to see that equipment is operating properly and efficiently is to check the instrument readings against the computed readings, and if there is any variation it is either corrected by proper manipulation or else the cause for the variation is ascertained and proper action taken.

In addition to the recording instruments provided, there are five rather large log sheets kept at the station, on which all the important operating conditions are recorded half-hourly and hourly, so that the major conditions are always available for reference from the log sheets. Each morning a meeting of the operating supervisors is held to analyze the major results of the previous day's run.

To assist in the computations, charts have been developed which not only reduce the labor involved in obtaining the required values, but permit the results to be obtained very soon after the records have been sent to the office. Charts for figuring flue loss and boiler efficiency are reproduced herewith.

Extreme care must be exercised in the starting of the 50,000-kw. units owing to their size and the length of the spindles. This is particularly true of the tandem-compound units. The throttle must not leak while the unit is at rest, as the spindle will develop what is known as a "steam kink." This is likely to result in damaged blading when the unit is started; even if the kink is not so serious, the time needed for bringing the unit up to speed will be appreciably lengthened.

The following is a general outline of the operation of the auxiliaries. All the 2,300-volt motor-driven auxiliaries have push-button starting control and are thrown directly on the bus.

Both circulating pumps are kept running when a unit is in service, so that if one fails the vacuum will not be lost. During cold weather or when the river water is cold, we run the pumps at low speed as this gives sufficient vacuum and

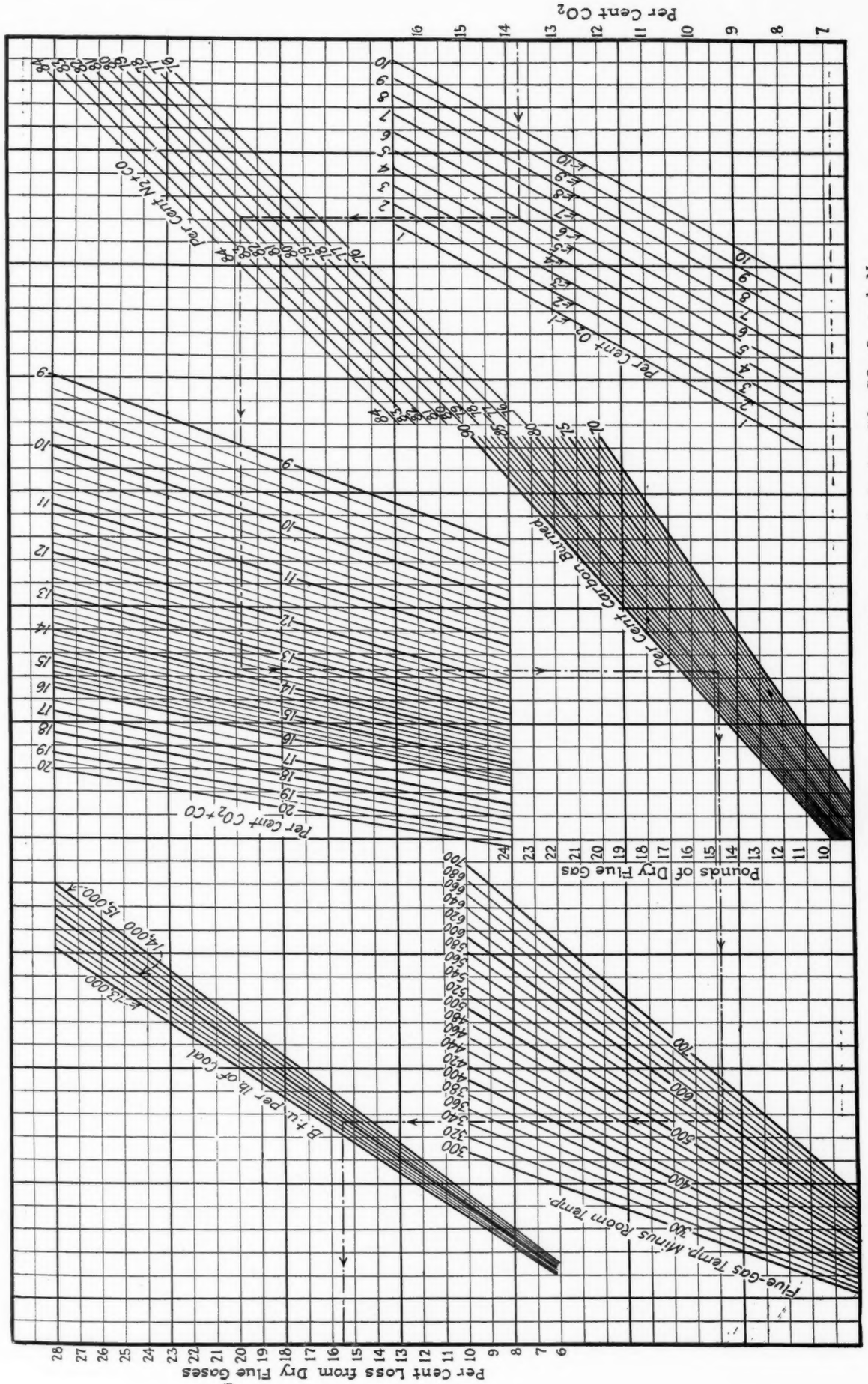

Per Cent CO_2
Per Cent Loss from Dry Flue Gases
Per Cent CO_2
Per Cent Carbon Burned
Pounds of Dry Flue Gas
Flue-Gas Temp. Minus Room Temp.
B.t.u. per lb. of Coal
Per Cent CO_2+CO
Per Cent N_2+CO

Fig. 4—Chart giving heat loss in dry flue gas, using complete gas analysis for CO_2, CO, O_2 and N_2. Unlike Fig. 2, which has a limited range, this chart may be used in any plant

makes an appreciable saving in auxiliary power. When the temperature of the river becomes such that the increased vacuum that additional circulating water will give is worth more than the extra cost of pumping this water, the circulators will be run at high speed.

To protect the boilers, one turbine-driven boiler-feed pump is kept warmed up and turning over slowly at all times, so that if one of the electrically driven pumps fails, it can be brought up to speed as quickly as the throttle can be opened.

The river water is so dirty that we have to clean the condensers two or three times a week. Whenever a unit is shut down, rubber plugs are forced through the tubes with compressed air. As the condensers are too large to clean all the tubes in one night (there are over

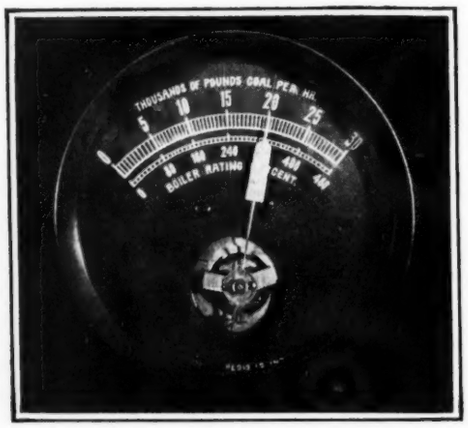


Fig. 5—Stoker speed indicator graduated in terms of boiler rating and coal consumption

13,000 tubes in each of the 70,000-sq.ft. condensers), about one-third of them are cleaned at a time. A record of the tubes that are cleaned each night is kept, so that same ones will not be cleaned the next night. During each cleaning the condenser is tested for leakage and any leaky tubes plugged.

Combustion Control to Reduce Banking Losses

Enough boilers must be available to meet the steam demands at all times. This means carrying more than are necessary over the periods of light loads with the consequent losses due to banking. It takes about fifteen tons of coal to bring up a boiler from a low bank and get it on the line. To prevent this loss we run the boilers during the day at about 125 per cent rating and push them up over the peak. When the automatic combustion-control system is put in service, we expect to operate more efficiently over a wide range of boiler ratings and save much of the loss now due to banking.

Owing to the great height of our boilers it is impossible to see the gage glasses well enough to tend water at the firing floor. Accordingly, the water tenders are stationed on a walkway just below the drums, where they have convenient access to the feed-water regulators, gage glasses and all feed-water control valves. A draft gage for windbox pressure is also provided on the water tender's walkway so that in case the gage drops due to shutting off the air the water tender will know the reason.

We have found from experience with our various boilers that we get much better combustion and better efficiencies by so operating the clinker roll that the top of the roll moves toward the bridge wall instead of away from it. This allows a slight barrier to build up and prevents an excess of air going up between the bridge wall and clinker rolls.

Starting a 50,000-Kw. Unit

Operators at other stations may be interested in the procedure when starting and stopping turbo-generators at the Hudson Avenue Station. The starting and stopping is carried out by a very simple and direct system of signals between the high-tension gallery and the turbine room. The high-tension operator begins the procedure by lighting the dome light over the turbine to be started. After lighting the signal "start" on the panel, he blows one blast of the whistle. With the exception of the whistle all signals are in duplicate for answering back. After checking preliminary conditions, the watch engineer quickly opens the throttle far enough to start the unit turning, at the same time noting the inlet pressure at the start. The throttle is closed as soon as the turbine rolls over. After a period of five minutes, during which the turbine rolls under its own momentum, the throttle is again opened sufficiently to maintain a speed of about 200 r.p.m. This speed is held for 30 minutes or until the turbine has become evenly heated. After this the unit is gradually brought up to speed, using about 30 minutes more, or one hour for the complete operation.

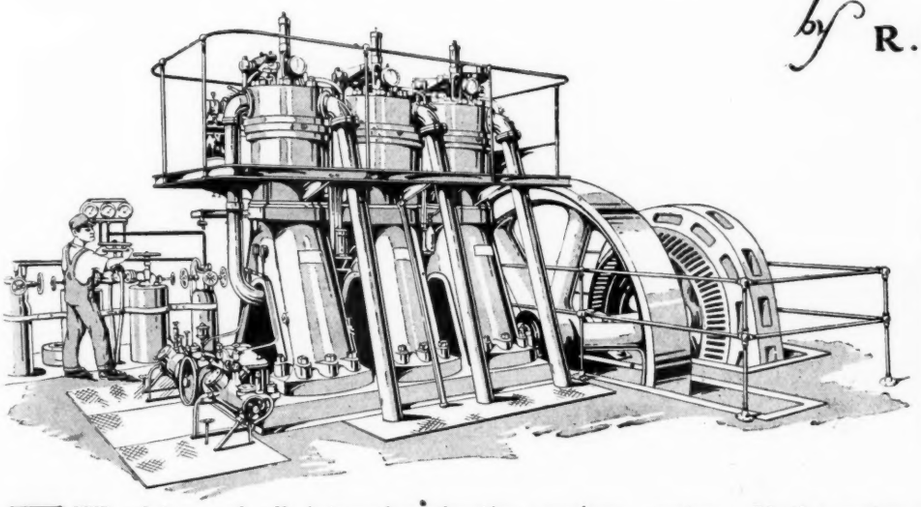
Shortly after the unit is started, the watch engineer signals "field" to the high-tension operator and the field is put on the machine. A rotary air pump is used in starting and then, after the unit is on the line, the steam-jet air pump is put in and the rotary pump shut down. The steam-jet air pump requires less attention than the rotary pump; is more reliable and requires less maintenance. It is, however, not well adapted to starting a unit because it requires cooling water, and this is obtained by circulating the condensate from the main unit through the cooling coils.

When the unit is up to speed, the watch engineer signals "speed" to the high-tension operator, whereupon the operator proceeds to synchronize the unit. As soon as the unit is on the line, the high-tension operator puts out all signals lights and gives one blast of the whistle.

A good way to check up the condition of the oil in a lubrication system as compared with the physical properties of the new oil is to take samples at regular intervals, as often as may be necessary, and have them analyzed. The condition of the oil can be determined satisfactorily by taking one sample from the oil line going to the bearings after the system has been in complete operation and thoroughly warmed up for some time. If the samples are taken too soon after starting up the machine, the oil is likely to be in a better condition than normal, as most of the moisture and sediment will have settled out while the machine was idle. In addition to the sample for complete analysis, it is a good idea to take samples once a week to check up the operation of the filtering and separating apparatus. These samples are taken only for the purpose of finding out the percentage of water and sediment in the oil as it is delivered to the bearings. One way of doing it is to fill a four-ounce bottle and set it away in a warm place for forty-eight hours. At the end of this time the sediment can be seen in the bottom of the bottle.

OPERATION OF DIESEL ENGINES

by R. Hildebrand *



Keeping the Piston in Condition Eliminates Waste

THE pistons of all internal-combustion engines have not only to transmit the forces resulting from the pressure inside of the cylinders, but they also have to make a tight seal against high pressures while moving with high speed and subjected to high temperatures. Their working conditions demand a good design, well-selected material, exact workmanship and proper care. It is of great importance that the piston is round when placed into the cylinder and that it stays round while in operation.

When driving a piston pin in place, the hole in the piston body, the pin and the bearing should be wiped clean and dry. After the pin is driven home, the piston should be "miked" to ascertain whether it is round or deformed from true roundness.

Generally, a power plant does not possess a sufficiently large micrometer or calipers to measure a piston. It is therefore suggested that the operating engineer make himself a set of tools of steel or induce the management to purchase a set. Fig. 2 shows an outside and inside micrometer for measuring the cylinder and piston, as well as the method of using the outside micrometer on the piston.

The rings and their grooves should be cleaned before putting a piston back into the engine and the carbon removed. For removing and replacing rings use four to six narrow strips of sheet steel, as shown in Fig. 2.

As the wristpin is wiped dry before it is placed in the piston and in the upper connecting-rod box, it is necessary to force lubricating oil into the wristpin box by means of a hand oil pump until it squirts out at both ends of the box. This should be done just before the piston is placed in the engine. At that time also rub lubricating oil on the piston and liner.

When putting the piston back in the cylinder, it is convenient to use a guide ring as shown in Fig. 1. If such a ring is not at hand, it is difficult to force the ends of each piston ring together when it enters the cylinder. It may also be used to grind the seat for the gasket used to seal the cylinder head.

Cooling the Piston

The heat absorbed by the piston top is dissipated by the cooling water. Large pistons are directly water-cooled, while small ones conduct the absorbed heat through the rings, piston body and liner into the cooling water. If the water cavities of the piston or the cylinder liner are coated with scale, the heat will not dissipate readily and a hot piston will result. This invites difficulties because the piston will expand unduly, reducing the running clearance between the liner and piston. In some cases the piston warps out of shape, and occasionally the wristpin runs dry.

All these difficulties can be prevented if the water passages are kept free from scale. The load should be kept equally distributed over all cylinders, as this will prevent overloading and consequently overheating of one or more of the pistons.

Fig. 3 shows one type of piston cooling device having separate inlet and outlet passages. Each of these consists of three tubes. The inner one is fastened to and travels with the piston, while the two outer ones are stationary. The inner stationary tube leads the water to and from the piston and carries at its upper end a stuffing box which makes a seal to prevent loss of water. The outer stationary tube also carries at its upper end a stuffing box which prevents loss of lubricating oil splashed on the moving tube from the wristpin bearing.

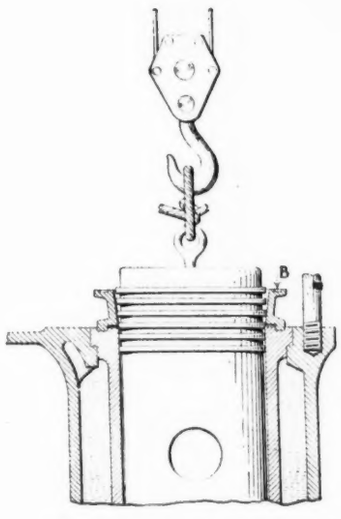


Fig. 1—Method of inserting piston

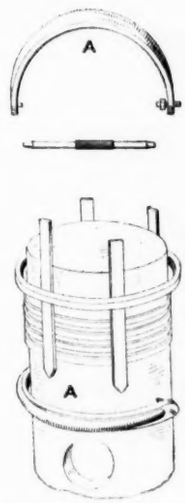


Fig. 2—Putting on the rings

Both stuffing boxes have the same gland ring, which simultaneously tightens both packings when the outer stationary tube is pulled downward. This tightening of the stuffing boxes can be conveniently done from below while the engine is in operation by means of a threaded sleeve having a locknut. The stationary outer tube not only serves for tightening both stuffing boxes from below, but it also serves as a drain in case either of the two stuffing boxes should leak. The drain chambers of the outer stationary tubes are connected by a small pipe leading to a visible outlet. In Fig. 4 is shown a swinging-joint water-cooling system; the outlet arrangement is identical with the inlet side.

No matter how the cooling device is designed, the problem for the operating engineer is in all cases the same; he must pack the joints so that no water can enter the crankcase. This should be done in such a manner that no unreasonable friction and wear of the moving parts of the cooling device will result.

The best packing with which the writer has experimented is the lip packing, Fig. 5. It does not grip the moving tube when the packing swells, although it is leak proof, for the water pressure always tends to press the packing on the tube.

Lubricating the Piston and Liners

The lubrication of the piston and liners is easily accomplished if suitable lubricants are used, properly applied, and if the liners are effectively cooled. The bad

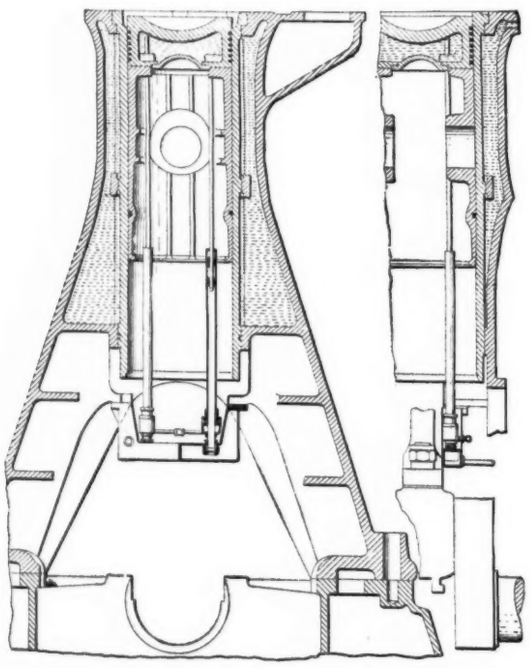


Fig. 3—One type of piston-cooling tubes

effects caused by using a poor grade of lubricant or insufficient cooling cannot be counteracted by applying an excess of lubricant to the cylinders. It will gum up the piston rings, resulting in blowing pistons, which is detrimental to the lubrication of the liners and pistons.

When inspecting the upper end of the cylinder liners, it will frequently be found that all pistons and liners are not equally well lubricated, although an equal amount of lubricating oil may have been fed to all cylinders. The cause of this uneven lubrication may be found in the timing of the cylinder lubricating pump. A lubricating oil pump may be timed just as easily as a fuel-oil pump. In a timed lubricating-oil pump the lubricant is discharged when the piston has reached its lowest position. The piston then wipes the lubricant up where the cylinder is hottest and where it is most needed. If the cylinder lubricating pump is not timed, the lubricant may be discharged in some cylinders when the piston is in its upper position, in which case a great amount of the lubricant is wiped down into the

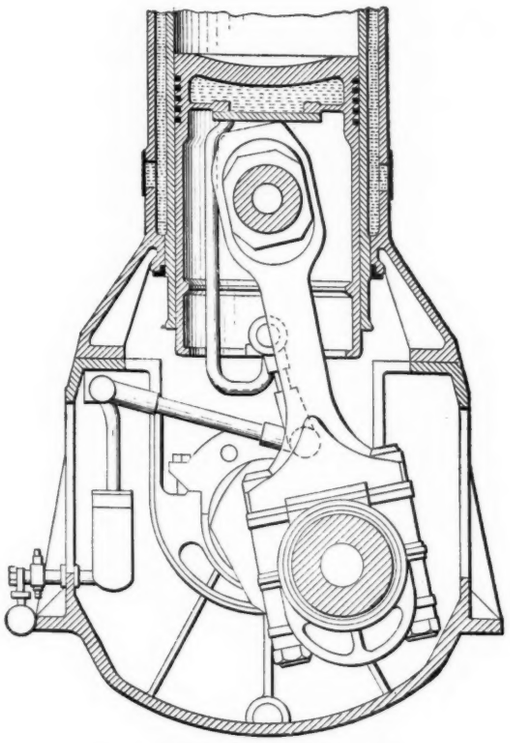


Fig. 4—Swing-joint water tubes

crank during the downward stroke of the piston instead of being wiped upward. The writer is convinced of the beneficial effect of timing the lubricating oil pump.

The design and the selection of the proper material as well as the manner of engine operation has much influence on the life of a Diesel engine piston. If the engineer will observe the following points, he will materially improve the operating conditions of the piston:

Keep the pistons and liners cooled as effectively as possible.

Equalize the load between the cylinders.

Be satisfied with nothing but good combustion, manifested by a clear exhaust and a low exhaust pressure indicated by a sharp-pointed indicator diagram, as this reduces the temperature in the engine to the lowest possible limit.

Use starting air of no higher pressure than actually needed to start the engine successfully.

Avoid, if possible, starting the engine immediately after stopping, that is, before it has cooled off. The expansion of cold starting air in a hot cylinder results in too sudden a chilling and consequently stressing of the material.

Seizing and sticking of a piston is generaly a sign of poor operation and can be traced back to causes already mentioned.

Knocking of the piston may be caused by natural wear of the liner and piston and also by too loose a wristpin

box. Whether the latter is loose can be determined by turning the crank in its lower dead-center position and by "jumping" the piston, that is, jerking it up, using a long heavy bar or timber. A dull pounding of the piston distinctly heard in the crankcase when the crank passes through its upper firing dead center, is caused by some misalignment. Either the crankpin and the wristpin or the two connecting-rod boxes are not in exact alignment. A knocking of the piston develops when the cylinder lubrication fails and the piston begins to run dry. The engine should be unloaded and stopped. The piston, provided it seized, should be removed and smoothed over with emery cloth. The liner should also

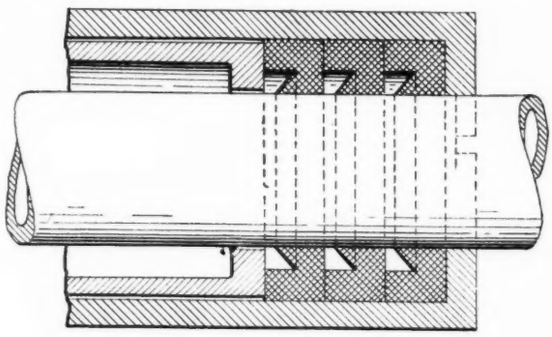


Fig. 5—Packing used on water tubes

be smoothed over by hand, using a carborundum wheel. While doing this work, the crank and its bearings should be covered with a canvas to prevent carborundum from entering the crankcase.

The wear on the piston rings is quite noticeable. If no pressure could come behind the rings the wear of the liners and rings would be very slight, because the pressure exerted on the liner due to the spring action of the ring is only 10 to 15 lb. per sq.in. This low surface pressure alone cannot account for the wear of the rings. The fact is, there is actually some pressure behind the rings because the rings must fit with clearance in their grooves. This pressure behind the ring is naturally greatest at the uppermost ring and may be several hundred pounds per sq.in. The pressure behind the second ring is less and behind the third ring still less, and so on. This explains why the upper ring always shows more wear than the lower rings.

It is erroneous to believe that liner wear results from the side pressure exerted by the piston body. This pressure is small, even if the pistons are of the trunk type, as the lateral component of forces on the piston, caused by the connecting rod amounts to only a few pounds per square inch, certainly not enough to explain the wear of the liner.

All liners of Diesel engines have a distinct tendency to wear to a taper, the greatest wear occurring at the extreme upper end. It is the pressure behind the piston rings which wears the liner, and since this pressure is maximum while the piston is in its upper dead center, gradually decreasing when the piston moves downward, it is not surprising that the liner wear is greatest at the top.

The question arises as to what can be done to reduce this wear to a minimum. The proper thing to do is to prevent as far as possible the pressure above the ring from finding a way behind the ring. This requires snugly fitting rings; the ring grooves are made 0.001 to 0.003 in. wider than the rings. This clearance increases gradually as the groove and the end faces of the ring wear until the clearance between the ring and the groove becomes quite noticeable.

It is necessary to keep the joints of the piston rings as tight as possible to prevent pressure being exerted from behind the ring. For this reason rings whose joints have opened up too much should be replaced by new ones. The opening of the ring and its joint is caused by the ring wearing thinner and the liner wearing wider. In replacing rings the gap should be as small as practical, allowing about 0.0015 of an inch per one inch of piston diameter to permit expansion of the ring due to heat. It should be kept in mind that when in operation, the ring has a much higher temperature than the liner at its lower end. If the gap in the ring joint is insufficient to allow for expansion, the ring may seize and break.

Cleaning Condenser Tubes

As a result of the greater attention being paid to the cleanliness of condenser tubes, which has been made necessary by higher vacuums and greater relative necessity for plant efficiency, it appears that methods of cleaning fall into two general classes.

In the first place, it is customary to clean occasionally in order to attain the vacuum requisite for best over-all station economy. Secondly, it has been found in some instances that aside from the usual cleaning it is sometimes desirable to make one of a more thorough nature. Some types of scale tend to accumulate in spite of ordinary cleaning, and by removing such sediment in a more elaborate manner, the desired vacuum may be obtained over a long period with fewer of the usual cleaning processes.

Sand entering with the circulating water has long been known as an efficient cleansing medium when present in suitable quantities and quality. The abrasive action appears well suited to offset scale that might prove too stubborn for many mechanical cleaning processes.

It has been further proved that sandblasting, where sand is applied by means of air at high velocity, will accomplish the same effect in removing the basic and more difficult accumulation. The fact that blasting of this kind at long intervals greatly helps the plant efficiency, was brought out by G. G. Bell, in the Prime Movers Report, N.E.L.A. Publication No. 24-78. Blasting with cinders collected from the roof of the plant instead of sand has in some ways proved equally satisfactory. Cleaning could be done just as thoroughly except that a somewhat greater quantity was required than sand.

Most important of all is the effect on the life of the tube of cinder blasting of this character. The report indicated that as a result of measured erosion, an equivalent of about 150 cleanings showed a loss of approximately 3 per cent of the weight of the tubes. If it is assumed that five such cleanings are required per year, the wear would be equivalent to around thirty years' life of the tubes.

The combustible matter present in ashpit refuse may be assumed, without appreciable error, to be pure carbon with a heat value of 14,600 B.t.u. per lb. It is unlikely that any great amount of volatile combustible could survive the distilling action of the furnace heat.

Cost of Power Losses in Electric Conductors

By Charles R. Underhill*

On the basis of 100 per cent conductivity copper at 68 deg. F., it can be shown that the energy loss per foot of single conductor, in *kw.-hr.* = $0.0104H\left(\frac{I}{A}\right)^2$, where *kw.-hr.* equal the energy loss in kilowatt-hours, H the number of hours the current flows, I the current in amperes and A the circular-mil cross-sectional area of the wire or cable. When the value thus obtained is multiplied by the cost in dollars per kilowatt-hours, the product is the number of dollars lost in heat per foot of wire or cable.

Recent quotations from a local jobber on rubber-covered stranded conductors were as follows:

COST IN DOLLARS PER 1,000 FEET

Size in Circ. Mils	Less Than 500 Feet	More Than 500 Feet
83,690	96.25	...
300,000	313	294
500,000	401	376
800,000	758	711
1,000,000	930	872

It is to be noted that the heat losses are based on a conductor temperature of 68 deg. F. Actually, the temperatures of wires indoors are considerably higher and the losses are from 5 to 10 per cent greater because of the increased resistance, so it is practicable to assume a slight decrease in the cost of conductor to offset the difference in temperature in obtaining the ratio of the annual loss in dollars, due to heating the conductor, to the initial cost of conductor.

Assuming 3,000 hours' use per year and the cost of electric energy as 2.5c. per kw.-hr., the number of times that the cost of the energy used in heating the conductors per year will pay the initial cost of the same conductors can be expressed as $N = 1{,}000{,}000\left(\frac{I}{A}\right)^2$, where I is the current in amperes carried by the conductor and A is the cross-sectional area of the conductor in circular mils.

If the number of hours is less or the rate is greater, corrections for actual conditions are easily made. However, the figures given make the rule easily remembered, and any necessary adjustments can be made after computing on the basis given. This formula does not include conduit, labor, and so forth, but it holds for any number of wires and regardless of the number of wires.

Example 1. The National Electrical Code allows 100 amperes as the safe current-carrying capacity of a rubber-covered wire having 83,690 circ.-mils cross-sectional area of copper (size No. 1). This is the maximum number of amperes that can be safely carried by the wire without reaching a temperature that would be injurious to the insulation. By the foregoing formula the number of times the money spent in heating the wire annually will pay the initial cost of the same wire, when the current strength is 100 amperes, is equal to $N = 1{,}000{,}000\left(\frac{100}{83{,}690}\right)^2 = 1.43$ times. That is, 1.43 times the amount of the same wire could be purchased annually with the money that is spent in heating it, on a basis of 3,000 hours' service and energy at 2.5c. per kw.-hr. A much better investment would be to use a 200,000-circ.-mil cable, since then the ratio would be equal to $1{,}000{,}000\left(\frac{100}{200{,}000}\right)^2 = 0.25$, that is, four years would be required to spend enough money in heating the cable to buy a new one. An idea of what the cost of the power losses may amount to, may be had by referring to the table.

Example 2. The National Electrical Code permits 200 amperes as the safe current-carrying capacity for 200,000-circ.-mil rubber-covered cable. Hence, $N = 1{,}000{,}000\left(\frac{200}{200{,}000}\right)^2 = 1$; that is, a new cable could be purchased every year with the money that is spent in heating it during the same period. It is to be understood, of course, that prices vary, but the object of this article is to show how money may be unnecessarily spent in heating wires and cables.

Referring to Example 2, let the power factor be 55 per cent on a constant-voltage system. Then, if the power factor was increased to 70 per cent, the current strength would be reduced to $200 \times \frac{55}{70} = 157$ amperes, and $1{,}000{,}000\left(\frac{157}{200{,}000}\right)^2 = 0.62$, which means that the money spent in heating the cable when the power factor is 70 per cent is but $0.62 \times 100 = 62$ per cent of that when the power factor is 55 per cent.

Increasing the power factor from 60 per cent to 75 per cent would reduce the number of amperes from 200 to, $200 \times \frac{60}{75} = 160$, and $1{,}000{,}000\left(\frac{160}{200{,}000}\right)^2 = 0.64$; meaning that only 64 per cent as much money need be spent in heating the wires when the power factor is 75 per cent as when it is 60 per cent.

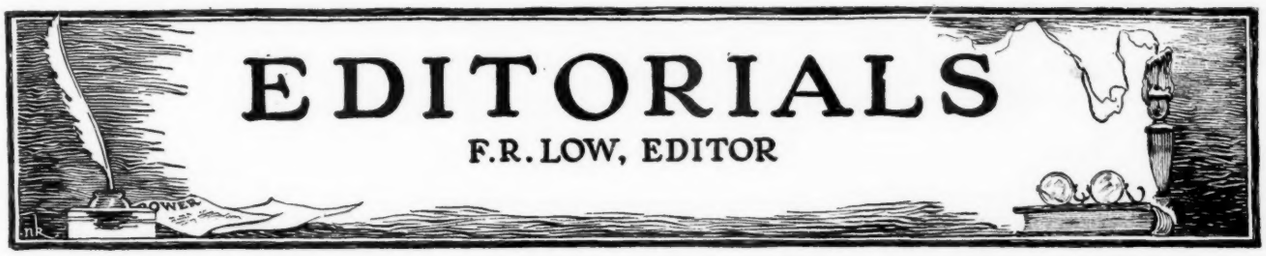
If the power contract rates were based on 70 per cent power factor, and for any other power factor the demand is multiplied by a factor that is represented by 70 divided by the actual power factor, then, while a saving of $\left(1 - \frac{70}{55}\right) \times 100 = 27$ per cent of the billing demand in a two-charge rate may be made in the power bill by increasing the power factor from 55 per cent to 70 per cent, a further saving of $1 - 0.62 = 0.38$, or 38 per cent, of the initial cost of the cable may be made annually by making the power-factor correction at the motor terminals, by properly loading the induction motors. This latter saving is lost when power-factor correcting devices are connected across the plant terminals without correcting the power factors of the individual motors.

Manufacturing-plant executives who think only of the cheapest and smallest conductors that can be used in their distribution systems supply lucrative loads for utilities and increase the latter's bank deposits.

The fact that the joints in the steam line do not leak is no assurance that the bolts in the joint are not crystallized and the factor of safety greatly reduced. If the line has been in service for several years carrying steam at high pressure and superheat, an examination of the bolts in the joints at the first opportunity may save trouble later on.

The persistent efforts to minimize the value of Muscle Shoals are suggestive that somebody is seeking to get it at bargain counter prices.

*Consulting engineer, Waterbury, Conn.



Modernizing the Power Plant

THE power plant is one place in the average manufacturing establishments where the manegement is in many cases apparently willing to lose money and do it with a good grace. Appropriations may be forthcoming to improve the manufacturing processes, to reduce the cost and improve the quality of the product, but the poor old power plant, as long as it meets the power requirements, is too often allowed to run along in the same old way. The fact that improvements in power-plant design and probably changes in the manufacturing processes have made possible rebuilding the power plant and obtaining large savings in operation, is something that is difficult to sell executives of the average manufacturing company. Strange as it may seem, most of the changes that are made are primarily due to the necesity of increasing the plant's capacity rather than to a desire to improve its economy.

There have been sufficient examples of rebuilt plants showing large savings to make most any executive give attention to what might be the condition in his power plant, but still a lot of them seem to be satisfied as long as that part of the business gives them no trouble other than paying the bills. An annual saving of three hundred thousand dollars as a result of investing fifty thousand dollars and incorporating modern operating methods in the power plant of a large manufacturing company, may be an exceptional case, but it does show that tremendous wastes may occur in a plant without those who control the purse strings getting excited about the waste.

Boiler Ratings

H. R. PARSONS, M. I. Mech. E., M.E.I.C., writing in *Engineering* on the Characteristics of Steam Boilers," says:

> There was a time when a water-tube boiler was supposed to be steaming at full load when evaporating 3.45 pounds of water from and at 212 degrees F. per square foot of heating surface. This is the basis of the American system of rating, so that when an American engineer states that his boilers are working at, say, 200 per cent of their rating, all he means is that they are evaporating the equivalent of 6.9 pounds of water from and at 212 degrees F. per square foot.
>
> The American nomenclature in this respect is not worthy of imitation, and the custom in this country of calling the rating of a boiler the number of pounds of high-pressure steam per hour which the makers guarantee it to produce is not only more logical, but has a certain analogy in the way the word "rating" is used in connection with electrical machinery.

We are attempting to substitute 1,000 B.t.u. for the heat of evaporation from and at 212 degrees as the unit of evaporation, and to get rid of the old unit of 30 pounds per hour from feed water of 100 degrees into steam of 70 pounds pressure from which, in connection with the allowance of ten square feet of heating surface to a horsepower, the 3.45-pound unit at which Mr. Parsons balks is derived. Perhaps we can get a unit of capacity based on this simpler unit of evaporation, 1,000 B.t.u. per minute, for example.

Mr. Parsons draws characteristic load curves of several boilers which go to show that in any particular boiler a low rate of steaming is more efficient than a high one, and raises the question whether it would not be more economical to keep all the boilers on the line, reducing their output equally when the load is light in preference to banking some and running the others at full load. It is rather widely recognized here that it is unwise to bank a boiler until all the boilers on the line have come down to a low load—lower than is common practice. Perhaps fifty per cent of rating is a fair figure for the limit.

Power Committees

A PROMINENT engineer associated with a large power company recently expressed the opinion that much of the valuable time of busy engineers is wasted by attendance on committees whose work is being more or less duplicated. He felt that it was about time for engineers to consider the efficiency of their professional organizations and that great savings might be made in this line of activity through reorganization and cooperation. This man gave expression to the thoughts of many power engineers, for professional activities in this particular branch threaten to become a burden to many. If one will compare the membership of various committees, he will be impressed with the fact that the same men are taking an active part in the committee work of more than one organization. This effort takes time and expense. Can our present plan of organization be improved?

Among our most active committees on power development are the Committee on Steam Turbines and Generators of the Association of Edison Illuminating Companies and the Prime Movers Committee of the National Electric Light Association. Both committees have done excellent work and their annual reports are valuable. The membership, however, is restricted to certain of those engaged with the large public utilities companies. One even hears the criticism that the Prime Movers Committee has become so large and the reports so elaborate that much of the time at its meetings is spent on organization details and editorial discussion. The N. E. L. A. also has Prime Movers Committees in its geographical divisions.

Several of the large holding corporations have their own intercompany committees which do excellent work. One of these has a small membership and hence devotes its whole time to problems of plant efficiency.

There is also the Power Division of the American Society of Mechanical Engineers. This has developed

into a strong, aggressive organization where all developments in the line of theory are now presented in the form of papers. However, here again size has become a consideration for it is scarcely possible in a meeting attended by several hundred members to bring out all the worth-while ideas on every subject under discussion.

The American Institute of Electrical Engineers, the Association of Iron and Steel Electrical Engineers and other organizations all have their Power Committees or divisions, and certain valuable papers and contributions are presented by each.

All of this indicates that there is great activity and lively interest in power matters. There is much work connected with these committee activities, and this largely falls on a group of leading engineers in this line. One cannot help wondering whether we are organized for most effective work and whether something cannot be done to centralize and conserve our efforts. Committee meetings, conventions and local meetings are making heavy demands on the time of the power engineer. Something must be done to lessen these demands or he will soon have little time left for his own business. The time seems ripe to give some consideration to the efficiency of our organizations.

Large Facilities for the Small Manufacturer

WHILE the small manufacturer may have the advantage over the large corporation in a few respects, chief of which is his ability to keep in close personal contact with his entire organization, the large manufacturer has more things in his favor. Tempting producers of raw materials with huge orders, he can buy at rock-bottom prices. His volume of business permits full use to be made of automatic machinery and specialization to cut production costs to the bone. These advantages are well recognized.

Somewhat less attention has been directed to the fortunate position of the large manufacturer in the matter of scientific research, testing and other technical services. Every year industry becomes more dependent upon science and research. The large manufacturing establishment finds an adequate testing and research laboratory fully equipped and manned by the best available talent to be a first-class investment. In fact, the research laboratories of some of the large corporations have proved to be veritable gold mines. These same corporations find it economical and profitable to maintain specialists in economics, finance and other lines to handle special technical problems that arise.

In these respects the small manufacturer is now at a great disadvantage. With from 50 to 200 employees he maintains at the best a one- or two-man laboratory carrying on routine tests of the simplest nature. As often as not there is no laboratory at all. Any attempt to organize his technical service on a large scale would swamp him with overhead.

A practical suggestion for the relief of this situation has just been made by Lewis A. Wilson, Director of the Division of Vocational and Extension Education, New York State. What Mr. Wilson proposes is not a college or technical school as these terms are ordinarily understood, but a state institution devoted as much to the furnishing of general and special information to manufacturers as to industrial education.

The proposed institution would comprise a department of industrial information, designed to aid manufacturers planning to locate in New York State, a department of chemical and physical research, a statistical research department to study and forecast industrial conditions, a department of factory construction, one of accounting and business methods to provide the small manufacturer with the best advice in these matters, and finally a department of trade and technical training.

The department of chemical and physical research would not only investigate research problems of general interest to manufacturers, but also furnish a special testing service that would give the small manufacturer the advantage of a first-class testing laboratory whenever the need arose. The department of trade and technical training would offer resident and correspondence technical courses of less than college grade for those desiring to enter industry or already employed.

In view of the public benefits resulting from the expenditures made in the interests of agriculture (the farmers constitute less than eight per cent of the population of New York State), state support of such a technical institution would seem to be economically warranted. The idea might well be considered by other industrial states similarly situated

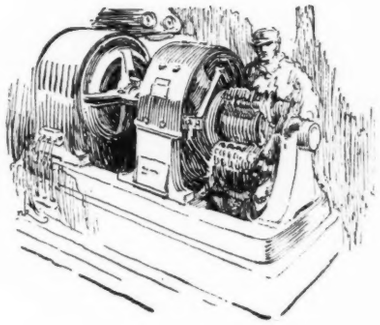
Motor-Generator Set Efficiency

ONE of the objections raised against a motor-generator set, consisting of a synchronous motor driving a direct-current generator supplying power to adjustable-speed motors, is the low efficiency of the motor and generator combined. If the efficiency of the motor-generator set is considered only, the case does not look very favorable for the use of direct-current motors, but if the benefits of having the synchronous motor on the system are included, the problem takes on a different aspect.

The power factor of the system must be included in the consideration of any alternating-current power problem, and when using a motor-generator to supply power to direct-current motors, the saving due to improving the power factor of the circuit must be considered. Although adjustable-speed commutator-type polyphase motors have power factors slightly less than unity at high speed and full load, at slow speed the power factors drop to around seventy per cent. If the motors operate a considerable portion of the time at low speed, the power factor is going to be low with corresponding increase in power losses in the distribution system.

While the efficiency of commutator-type adjustable-speed alternating-current motors may be higher than for direct-current motors with their conversion apparatus, if the effects of the direct-current load and the synchronous motor on the system's power factor are considered, the efficiency may be in favor of the motor-generator set. Furthermore, where power is purchased and a power-factor penalty clause is included in the rates, the improved power factor obtained by using the motor-generator set may result in a reduction in power rates. The motor-generator set in general is limited to cases where a group of motors are to be supplied, but even here it has large possibilities for assisting in solving the power-factor problem. Furthermore, the direct-current motor is a machine that the average electrician or operating engineer feels competent to handle.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for April will be announced next month.

Who Is to Blame?

Some time ago I had occasion to visit a small plant and was much impressed with the conditions there. On going into the engine room I found no engineer. A Corliss engine of about 175 hp. was running with apparently a light load. The outboard bearing was covered with dirt, and the oil from the bearings drained into a pan and finally into a pail. In one corner of the room was a closed heater and close to it, but nearly covered by the floor, was what appeared to be a vacuum pump, which was leaking badly. The compound gage connected to the pump registered 12 lb. gage. The bearings of the overhead shafting, from all appearances, had not been cleaned for a long time. A small generator that was driven from a countershaft looked more like a vale of dust with a revolving center than a generator. In the other end of the room was a belt-driven pump which was put into operation by using a broom handle to shift the belt from the idler pulley. When the pump was in operation, it made so much noise that it could be heard a long distance. Considerable high-pressure steam was going to waste through a leaky whistle valve.

Still not seeing anyone, I looked for an engineer's license and I found what I expected, a very untidy affair. I then looked for the boiler room and there found a man lying on the coal pile (not asleep, just taking it easy). He did not stir at my approach, and when I asked for the engineer he got up and informed me that he was the engineer. He remarked that it was an old man's job. I suppose this was an excuse for the condition of things. He burned about 3½ tons of coal a day, and by the date of his license, which was a first-class one, he had been an engineer for over twenty years and certainly should have had pride enough to live up to the dignity of his license.

Even if the owner did not or would not furnish funds to buy new equipment, there was no excuse for the untidy condition of the plant, for if he had cleaned up once it would not take much time or effort to keep it clean. Of course a man may get discouraged by not having the co-operation of his employer, but lying down on the job will not help matters any. How different it is to tell someone else to do a thing than it is to do it yourself! I feel safe in saying that if this man had had another engineer under him, he would have instructed him to clean the engine, sweep the floor and not to lie down in the few spare minutes he might have to himself. If it was a man-kililng job there might be an excuse, but even then someone could be found to clean up once in a while. Would one care to hire this man to take charge of one's plant? Does not the first impression have a great influence on one's decisions?

Now, if an engineer in the true sense of the word went into this plant, he could, by a little cleaning up and application of some paint, make a remarkable improvement in a short time. Then he could call in the owner or superintendent and show him what he had done, which would react in his favor, and it would not be long before he would be allowed to buy new equipment or make improvements. Although this man could probably set valves and do other work well, is not this condition enough to mar his reputation as an engineer, and certainly bring no credit to the owner?

Needham Heights, Mass. GORDON M. PHINNEY.

Suggestions for Packing Through Stays of Boilers

To many engineers operating return-tubular boilers the leaking of the through stays at the front head is a source of considerable annoyance. No matter how carefully they are packed and the nuts drawn up, the leak seems to recur.

The last time I repacked the stays on my boilers, I placed a ⅛-in. thick copper washer over the rods between the nuts and head. I cut the hole in the washer a little small, then shaped it as shown in Fig. 1. After placing one of these washers over each rod and before drawing up the nuts, I wound a little packing between the washer and nut. Then in drawing up the nuts the packing was compressed and at the same time the

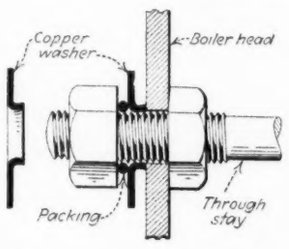


Fig. 1—Copper washer and packing inserted between the nut and head

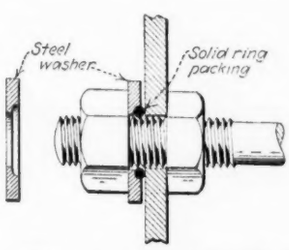


Fig. 2—Steel washer with concave recess used with asbestos packing ring

raised part of the copper washer was forced into the space around the rod in the boiler head.

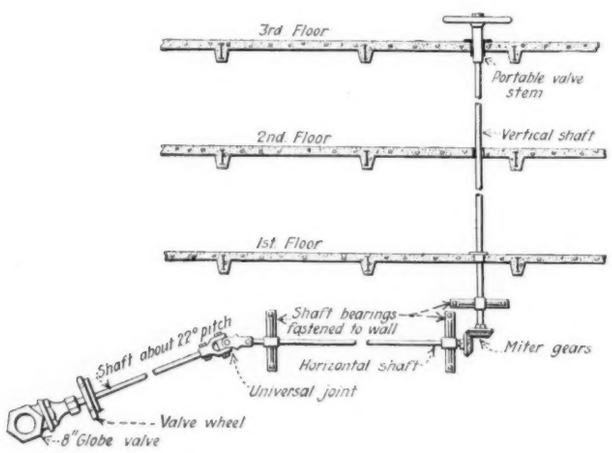
This work was done about two months ago, and so far there is no sign of a leak at any of the bolts. If I have any more trouble with leaking nuts, I intend to use the method of packing shown in Fig. 2. The steel washer is made with a concave recess in one side to take a special asbestos packing ring. The packing ring is made somewhat larger than the concave in the washer so that when drawing up the nut the packing will be forced against the boiler head and rod. When tightening up the nut, the washer is held with a pipe wrench to prevent it from turning and destroying the packing. Some boilermakers have attempted to overcome the leaking at the through rod by recessing the nut like that shown in Fig. 2, but this is not so satisfactory, as the packing tends to squeeze out when turning up the nut. This difficulty is overcome, however, by using the washer shown in Fig. 2. H. A. JAHNKE.

Milwaukee, Wis.

Remote Valve Control

The lack of control of the steam for central heating systems is usually responsible for a waste of a large portion of the steam. I have made a study of the control of steam by automatic temperature-control valves, by manual control, etc., and find that automatic temperature control reduces bills about 40 per cent. Often a valve conveniently located for manual control will help save a large amount of steam. A plan that has proved successful and economical is shown in the illustration.

It was necessary for a building owner having his office on the third floor to go to the basement in order to shut off the steam. On certain days this either



Service valve in basement is opened or closed from the third floor

required several trips or a waste of steam. The heat could not be controlled before 8 a.m. or after 6 p.m. as the first-floor store locked up the rest of the time. This caused all-night service, which meant that the bills were double what they should have been. The owner of the building called on the writer, who made the arrangement shown in the sketch.

The service valve was under the sidewalk, which caused a horizontal run of 50 ft. to the inside of the building. As the valve was on a horizontal line and the valve stem was at an angle, it required the use of a universal joint, 22 deg. pitch, miter gears, shaft supports, portable valve stem, etc.

With this arrangement the valve can be turned on and off either from the basement or from the third floor. This plan reduced the steam bills the first heating season from $5,000 to $3,000. The cost of the work was $85. H. W. WOODWORTH.

St. Louis, Mo.

How the Valve Setting Was Improved With the Aid of the Indicator

The accompanying indicator diagrams, taken some years ago from a horizontal cross-compound condensing engine, may be of interest to readers of *Power*.

The manufacturing plant where the diagrams were obtained was operated both by steam and water power.

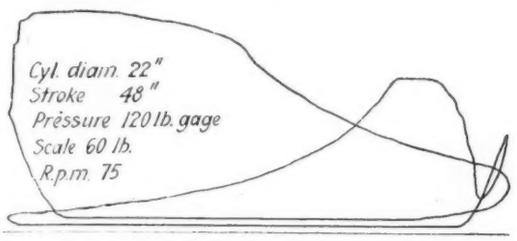


Fig. 1—First diagram taken from engine showing unequal distribution of load

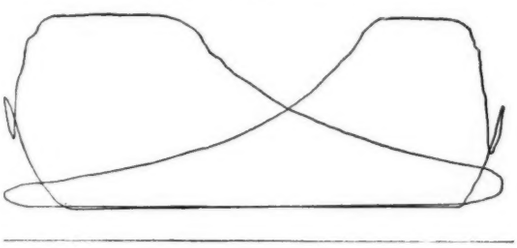


Fig. 2—Diagram obtained after equalizing travel of wristplate

The engine was used as a stand-by and was operated occasionally for periods of several days in place of the waterwheels. When in operation the engine had a heavy knock in the main bearing on the high-pressure side and also ran very hot. The operating crew used all kinds of tallow, grease and other mixtures of lubricants, combined with engine oil to keep the bearing cool. At the time of my visit they were using slabs of salt pork pressed down through the handhole in the bearing cap, with fairly good results except for the unmistakable odor of frying pork around the engine room. Also, there was so much oil used on this bearing including an occasional charge of water that everything around the place was coated with oil and grease.

The diagram, Fig. 1, shows the condition of the valve setting as found. This, apparently, was the first diagram ever taken off the engine, as it was necessary to rig up piping and drill the crosshead for an attachment for operating the indicator.

Diagram Fig. 2, shows the change made in the distribution of the load after the eccentric rod was lengthened to make the wristplate travel nearly an equal distance each side of the center. It also shows the lead to be late and compression beginning too soon.

As nothing further could be done till the engine could be shut down, diagrams were taken from the low-pres-

sure cylinder, one of which is shown in Fig. 3. The diagram shows piston leakage, as indicated by the rise of the expansion line, which no doubt, accounts for the low vacuum.

The diagram Fig. 4 was taken after several adjustments had been made to the valve gear. The steam eccentric was advanced $\frac{1}{16}$ in., the exhaust eccentric was

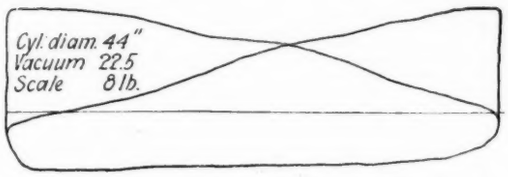


Fig. 3—Diagram from low-pressure cylinder

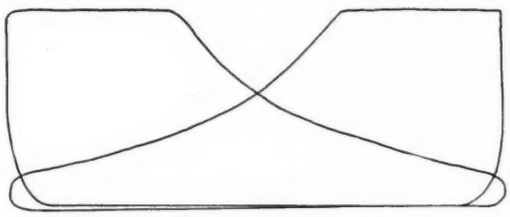


Fig. 4—Diagram from high-pressure cylinder after adjusting valve gear

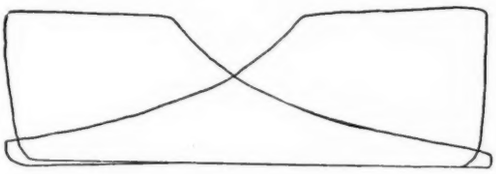


Fig. 5—Diagram taken from same engine four years later

pulled back $\frac{1}{4}$ in., the eccentric rod was lengthened $\frac{7}{32}$ in., new rings were fitted to the piston and the valves were filed up. Incidentally, the bearing shells were removed, cleaned up and new oil grooves cut. When the engine was again put in service it operated finely and the knock had disappeared.

It was suggested to the management that they buy an indicator and use it occasionally. They must have invested in one, as the diagram, Fig. 5, sent to me four years later by the master mechanic, shows the engine in good shape, as the diagram is fine. J. F. NAGLE.

Brooklyn, N. Y.

Ammonia Liquid Gage

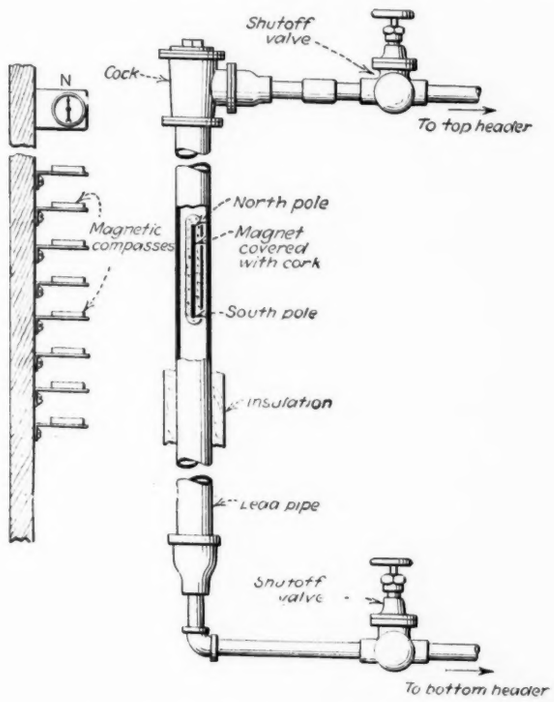
A simple and effective gage with which the level of ammonia in the refrigerating coils of the brine tank may be determined with a close degree of accuracy, can be made from a magnetized bar and a few cheap magnetic compasses.

First a lead pipe about $1\frac{1}{2}$ in. in diameter and 2 ft. long is insulated with 2-in. thickness of cork. One end is soldered to a reducing nipple to take a $\frac{1}{2}$-in. pipe and valve making a connection to the bottom header or lowest point of the coils. The other end of the lead pipe is flanged and a cast-iron cock is attached, the cock being connected through a reducing nipple and valve to the top header of the coils. The floating magnet is then made by magnetizing a piece of $\frac{3}{8}$-in. tool steel bar about 6 in. long and insulating it with cork, or a magnet can be purchased that is covered in cork of sufficient quantity so that it will float. The cork covering in either case must be treated with paraffin wax to make it impervious to moisture.

The lead pipe is then connected to the coils in the same manner as a gage-glass indicator would be, taking care that the small valves are closed. The plug of the cock is then removed and the magnet is inserted, the plug replaced, valves opened and the ammonia allowed to circulate.

In order to indicate the level of the liquor in the lead pipe, a series of six or more small magnetic compasses, such as can be purchased for a small sum, are mounted on a board, one above the other, at a distance of 2 in. apart. The board is installed about 3 ft. from the pipe in such position that the series of compasses will be at about the desired level of the liquor.

The level of the ammonia can then be determined by reading the compasses, which, as the north pole of the floating magnet is raised or lowered in the pipe, so will it repel the pole of the magnetic compass. Should it rise sufficiently for the south pole to repel the corresponding pole, this can be readily seen from the change in position of the magnet in the stationary compass.



Arrangement of floating magnet and compasses for indicating ammonia level

This simple gage has been tried out and is in constant use on an ammonia system, and the level can be read to a comparatively close point by placing the compasses closer together or by adding more to the series. The magnets do not become demagnetized easily and, as they are cheap, can be easily replaced; also it is a simple matter to close off the gage and remove the plug cock to insert a new magnet, should the cork get liquor-logged. MAURICE C. COCKSHOTT.

Los Angeles, Calif.

Comments from Readers

Placing a Fuel-Oil Tank Underground

Referring to the article by Mr. Fette in the March 31 issue on "Placing a Fuel-Oil Tank Underground," in which he illustrates the manner of rigging up two gin poles with the necessary tackle and winches to lower the tank into the hole, it seems to me that this operation entails considerable labor.

Having noticed articles from time to time along the same line, it has often occurred to me that the lowering of the tank could be simplified in the following manner: Fill the hole with water and with the tank sealed, roll it over into the water where it will float, then right it, secure it from rolling and pump the water out of the hole, and the tank will settle on its foundation.

New York City. E. C. GRIEF.

Utilizing Waste Firebrick

I read with considerable interest the comments of James Johnson, in the April 21 issue on "Utilizing Waste Firebrick" with reference to an article by Joseph Harrington on "Ground Firebrick for Furnace Repair," in the June 17, 1924, issue and the comments of James A. Faulkner on the subject in the Jan. 20, 1925, issue.

Mr. Johnson opines that this process could be of benefit only to certain plants, and particularly where there are a number of men employed "who have little or nothing to do" at times, and whose time could be utilized for preparing a ganister made of crushed brick and high temperature cement.

Inasmuch as I have had considerable experience in monolithic construction, where discarded firebrick were ground and bonded with high-temperature cement, and through my activities, the first article by Joseph Harrington, previously mentioned, was a direct result, I feel qualified to elaborate on a few points. It is not a question so much of having a "number of men" to warrant an installation of this kind, as it is a sufficient number of furnaces to warrant the expense of installing machinery to obtain adequate economies through the medium of monolithic walls.

In the first place, unless a grinder for crushing firebrick bats is at hand, it certainly would not pay to use old firebrick. In the second place, unless a mechanical mixer, which is capable of both crushing and mixing, is used, neither economies nor success will be obtained. There cannot be a uniformity of ganister, with the necessary uniformity of bond, through the means of hand labor in every installation, when a wall of any size is attempted. It is all very well to use hand labor for one installation in order to determine the success of monolithic construction, and care must be exercised to see that a uniform bond and a thorough mix is obtained; but economies cannot be effected for this class of work unless a mechanical mixer is used. Then again, as previously mentioned, equipment that would run into several thousand dollars would be prohibitive unless the plant had at least twelve furnaces, and one of these to spare, in order to provide sufficient time to make proper installation.

It must be conceded that firebrick that have been used in the furnace (or rather what remains of the original setting that has been removed) possess value as refractory by virtue of the extra calcining. The problem is, how to utilize them effectively. With a sufficient number of furnaces that discard a sufficient quantity of old firebrick bats, there is no doubt that a mechanical mixer could be employed with resultant economies; but even so, there also must be favorable conditions in the furnaces themselves to warrant monolithic construction. Before an engineer, with the required number of furnaces, recommends the purchase of machinery to utilize the old firebrick bats, he would do well to get some expert advice on this subject.

New York City. FREDERICK W. REISMAN,
President, Keystone Refractories Co.

Shall He Take a Chance?

Having read the foreward on "Shall He Take a Chance?" in the April 14 issue, I am prompted to ask the questions: Is not the era of self-trained men past? Is not the man referred to held back largely because of his lack of a college education?

I am twenty-four years old and have been unable to obtain a college education. I have spent much time and considerable money endeavoring to educate myself for a position in the engineering field. I am employed as draftsman by a concern that positively offers no advancement except to college men. The advertisements in the technical magazines presenting available positions, specify college education as a requirement.

If the well-trained man referred to in the "Foreword" is finding difficulty in having his ability recognized, the opportunities seem rather poor for a young man trying to start out without a college education.

The recent college graduates with whom I come in contact, apparently have no more knowledge of engineering than myself, but seem to take their opportunity more for the prestige that it entails than for the chance of obtaining a thorough knowledge of their profession. Comments from other readers on this subject might prove of interest. GORDON G. BROWN.

Utica, N. Y.

Glassless Gage Glass

The article on "Glassless Gage Glass," in the March 24 issue, is of particular interest to me, and I make this assertion for the following reasons:

In November, 1923, I sat in a conference at New York with Lord Weir, of C. & J. Weir, Ltd., Cathcart, Glasgow, and at that time the possibilities of the generator principle were gone over thoroughly with reference to high pressures, one of the points covered being the fact that the generator, when operating in connection with a feed-water regulator, could be used as

a water-level indicator by the use of a properly calibrated gage.

It seems that I did not make it clear at that time that the principle was fully developed and in use even before that date. The same idea has been incorporated in steam automobile and truck work so as to have the water-level gage on the dashboard of the machine.

In a way I regret the necessity of exploding the idea of another new invention. However, in view of the fact that it is not new and has been in use, the actuating principle patented in the United States, I will subdue my regrets and let the facts appear.

Fostoria, Ohio. J. M. BARRETT,
The "S-C" Regulator Co.

Suggestions on Boiler Furnace Design

The articles by C. M. Garland entitled, "Suggestion on Boiler Furnace Design," in the Feb. 3 issue, and "Furnace Designs for Coal and Wood Refuse," in the March 17 issue, are interesting, and in general I agree with him, though on some points my experience has been different from his. Also, one or two points seem sufficiently at variance with usual practice to make one suspect that he has been misquoted; for example on the absolute temperature of the boiler heating-surface, which is given at 2,000 deg. F., whereas it seldom exceeds 850 deg. F. (abs.), and again that 40 per cent of the heat of the fuel is transmitted to the boiler as radiant heat, as it seems doubtful if such an absorption is being obtained even with the water-cooled side walls such as were used on the Hell Gate plant tests.

Mr. Garland shows some interesting furnace designs, but, as he admits, they have a rather limited adaptability to a variety of fuels; that is, those designed for low-grade fuels are likely to be seriously affected in a short time in running on higher-grade fuels which would give excessive furnace temperatures. The arrangements shown with hanging walls are particularly susceptible to such damage, and similar ones have given considerable trouble in both the New York Edison and the Detroit Edison plants, descriptions of the experience with them being available in the "A. S. M. E. Proceedings." In this connection, too, it is not emphasized that the arrangements shown are only one of several possible courses, none of which has probably been tried out under a sufficient variety of conditions to prove its desirability over the others.

As it is impossible to foresee all the irregularities that may occur in fuel supply in the life of a boiler plant, it is desirable to equip the boilers with furnaces that will give the best efficiency with the most available and cheapest fuel under normal conditions, without making it unduly expensive or slow for changing to another fuel which seems the most probable substitute in case of failure of the first. Therefore it might be advisable to install practically a standard boiler furnace and treat the low-grade fuel so that it could be burned in it satisfactorily, rather than equip the boiler with a special and expensive furnace of limited adaptability to higher-grade fuels. For instance, with wet wood waste considerable progress has been made in Sweden in rolling or pressing it to extract the water and provide a more readily handled and drier fuel. There also seems a large field in the application of the experience gained in drying coal previous to pulverizing, particularly in open rotary driers by means of the gases; to the drying of low-grade wet fuels, which would materially increase the capacity and efficiency of the furnace or allow the same results to be obtained with a cheaper and simpler design.

It would also seem, considering the experience of the Adirondack Power Co. with mixing arches for Coxe stokers, as described by Messrs. Denny & Shondy in their recent A. S. M. E. paper, that Mr. Garland is unduly pessimistic regarding their possibilities, as these tests showed no appreciable choking of the draft, and with such a venturi form of gas passage the actual pressure drop between the grate and tubes should be small despite the increase of velocity and considerable agitation at the restricted passage. From experience with steam-jet smoke consumers, etc., it seems possible that Mr. Garland is expecting too much of the gas-mixing jets, as some elaborate tests with similar apparatus on which I assisted showed in most cases that the rate of combustion decreased in nearly the same ratio as the smoke.

Regarding the relative usefulness of stokers the overfeeds have apparently been losing ground steadily to the underfeed types, as they are outclassed in economy, flexibility, range of adaptability to varying coals and loads, and, a very important consideration for the city plant engineer these days, smokeless combustion. Most overfeed stokers have one rather small range of rate of combustion for each fuel to which they are adapted, and when an attempt is made to thicken up the fire and force them beyond this point, the agitation is not sufficient to keep the fuel bed open and they automatically bank themselves. At lower rates the coal feed and agitation are so linked that when the proper amount of fuel is being fed, the agitation is not enough to keep the fire uniform and it burns out in holes.

Mr. Garland seems to have been particularly fortunate in his experience with the V-type overfeed stoker, which is particularly adapted to the Mid-western coals common in his section, rather than to the stronger-coking Eastern coals. I have found, in taking traverses across boilers fired with stokers of this type, that near the wall the CO_2 is low owing to air infiltration, it then rises to a maximum about one-third the way across the boiler over the zone of most active combustion, drops off considerably at the center over the clinker bar, rises again to a maximum over the other combustion zone and falls away somewhat at the middle wall. Longitudinally, too, there is considerable variation, as practically all stokers of this type have ventilating ducts for the arch which discharge into the first pass just at the front end of the tubes and dilute the gases.

A furnace of this shape is preferable to the single inclined grate shown by Mr. Garland, as increased radiation is obtained not only from the arch, but from one body of fire to the other in the combustion of wood refuse or such low-grade fuel that will not slide too readily on the grates. An angle of 45 deg. seems pretty steep compared with the 33-deg. angle of the usual V-type stoker or the 23-deg. angle of the old Roney type.

Natural-draft chain-grate stokers work under almost prohibitive operating conditions. As soon as an attempt is made to burn out the refuse thoroughly, holes appear near the rear and the air which should be used in burning fuel at the front end of the grate short-circuits through them, thus adding to the excess air at the same time that the actual volume of products of combustion is decreased. The forced-draft type, worked with natural draft, allows of better air distribution, but the draft loss through the smaller air

spaces of the grate and ducts and regulating dampers is so great that the capacity is greatly reduced. The main field for the natural-draft chain grate is in very cheap high-ash coals, which clinker so readily that any disturbance of the fuel bed or mixing of the ash will form almost a solid slat of clinker, as in such cases the necessary flue-gas losses are less than the ashpit losses and expense of getting rid of the clinker in other ways.

Late developments of the underfeed stoker with extra-long patterns at low rate of combustion per square foot, high side tuyeres or other means of protecting the side walls, and possibly clinker guiders, have made it possible to handle some of the lowest grades of fuel successfully.

A great deal of testing experience has convinced me that with ordinary furnace heights, say 6 to 10 ft., the inclined-retort underfeed stoker with a reasonable amount of fire on the extension and dump grate is the only stoker that does not give an excessive amount of stratification of flue gases without special mixing devices, and considering the simple, strong and durable furnaces possible with them and the practically perfect mixtures obtainable in furnaces of somewhat greater height than those just mentioned, it is worth while making some concessions in other directions in the preparation or choice of fuels to allow its use.

Air-cooled side walls are necessary in many cases, particularly just above the grate line, to prevent the adhesion of clinker, but it is preferable with forced-draft fans to circulate part of the air from the discharge of the fan through the wall to be cooled and discharge it into the firebox through perforations in the side walls below the top of the fire, rather than to try to conduct this air to the fan suction. Natural-draft furnaces seldom generate high enough temperatures to require air cooling except with oil firing, where air cooling in the wake of the burner is very desirable.

As a rule, unless the external area of the furnace is very large compared with the heat developed in it, insulation of the furnace walls is a doubtful economy except as a measure of comfort for the firemen, as the total heat radiated from a boiler setting is a comparatively small fraction of that generated, and there are usually other places around a plant where an equal expenditure would produce greater returns. It has been my experience that the commercial insulating brick are too weak mechanically to be built into a boiler setting and require an expensive steel casing to hold them up on the outside of the setting, and that the stronger bricks with less insulating value could be replaced with red brick at the same cost and produce the same results.

Proper choice of clay for refractories so that they will not flux readily with the ash of the fuel, is a very important consideration in furnace maintenance and can be determined in the laboratory by fusion of small samples of a mixture of ash and pulverized brick or practically by observing the flowing of the wall surface.

New Haven, Conn. H. D. FISHER.

I think that Mr. Fisher has become confused over the statement relative to the heat absorbed through radiation. If it is assumed that the boiler pressure is 200 lb. per sq.in., the steam temperature will be approximately 388 deg. and the absolute temperature 847 deg. F. This, however, is the temperature of the water in the boiler, but not of the heating surface. This heating surface, which receives the heat direct from the furnace, is invariably covered with a layer of soot and ash, and it is not infrequent that when you observe this covering, it is at a red heat, which would indicate a temperature close to 2,500 deg. absolute. It is, therefore, believed that a temperature of 2,000 deg. absolute is probably a reasonable assumption. As a matter of fact, if it is assumed that the law of radiation is correct, some such temperature of 2,000 deg. absolute, is necessary, otherwise a greater percentage than 40 per cent of the heat would enter the boiler direct, which, of course, we know from practice is not the case.

Another matter that Mr. Fisher has overlooked is the fact that the conduction of heat through a boiler plate means a decided drop in the temperature, due to the plate itself, the film of water adjacent to the plate inside the boiler and the film of air or gas adjacent to the plate on the outside of the boiler, even assuming that the plate is perfectly clean on the outside.

From the many measurements taken to determine this drop in temperature by the insertion of thermocouples in the surface of the plate, the writer would be of the opinion that the drop in temperature between the outside surface and the steam or water in the boiler considering the low velocities maintaining in the boiler, would be in the neighborhood of 300 deg. The accumulation of soot and ash, however, on the heating surface exposed to the radiant heat from the furnace is what greatly limits the absorption of heat by the boiler. C. M. GARLAND.

Chicago, Ill.

Broken Valve on Air Compressor Causes Fire in Power Plant

In the March 24 issue F. C. Blomberg gives an account of the overheating of the discharge pipe of an air compressor. He attributes the trouble to a broken discharge valve permitting the air to leak back into the cylinder and be recompressed a number of times, resulting in a temperature increase to the point of ignition of the carbon deposit. This is an idea that refuses to down. It is offered now and then as a reason for the effect quite evidently caused by a mistaken or careless use of lubricating oil, together with failure to clean out the compressor and piping frequently.

It is my opinion that any air returned to the cylinder through leaking discharge valves will, by expanding and doing work against the piston, have a cooling effect, and cannot contribute to the high temperature sometimes attained. That fires do occur is not strange. Given single-stage compression to high pressure, the presence of coke having catalytic effect on oil vapor and the oxygen of the air, and combustion would seem inevitable. To avoid fires in compressor discharge lines and receivers, care should be taken that oil of correct quality and quantity be used and frequent inspections of the equipment be made.

It is sometimes thought that explosions may result from a mixture of oil vapor and air being ignited by the burning carbon deposit in compressor discharge lines and receivers. This is unlikely, as the burning coke will ignite the vapor as fast as formed, thereby preventing the accumulation of the comparatively large quantity necessary to form an explosive mixture in the volume usual in compressor practice.

Los Angeles, Calif. C. O. SANDSTROM.

Questions and Answers

Conducted by

Franklin Van Winkle

Pinholes in Galvanized Iron Water Pipe

We have a 1¼-in. underground water-pipe line which, after five years use, shows leakage at pinholes that have rusted through sections of the line that were laid of galvanized pipe, while sections of black-iron pipe appear to be in good condition. Does galvanizing decrease the durability? *E. H.*

When the galvanizing is well done and the impurities of the water are not especially corrosive to zinc, galvanizing increases the durability of the pipe. But where the coating is carelessly performed, leaving the surface uncovered in spots, such places are more rapidly affected by corrosion than black-iron pipe, probably as a result of galvanic action caused by difference in the rate of corrosion of the iron and zinc.

Standard Atmospheric Pressure

What is the standard atmospheric pressure and what is the temperature at which a 30-in. barometer would give the standard atmospheric pressure? *L. C. R.*

The standard atmospheric pressure at sea level and at latitude 45 deg. is 14.6963 lb. per sq.in., corresponding with the pressure exerted by a column of mercury 760 millimeters, or 29.921 in., high when the mercury is at the temperature of 32 deg. F. For any other temperature there will be a corresponding height of column of mercury because of the expansion or contraction of the mercury. The coefficient of expansion of mercury is 0.000101 per degree F. Therefore calling t the temperature when the standard pressure is exerted by a 30-in. barometer

$$29.921\,[1 + 0.000101\ (t - 32)] = 30, \text{ or } t = 58.15 \text{ deg. F.}$$

Hence when pressures are referred to 30-in. barometer the standard temperature of the mercury must be taken as 58.15 deg. F.

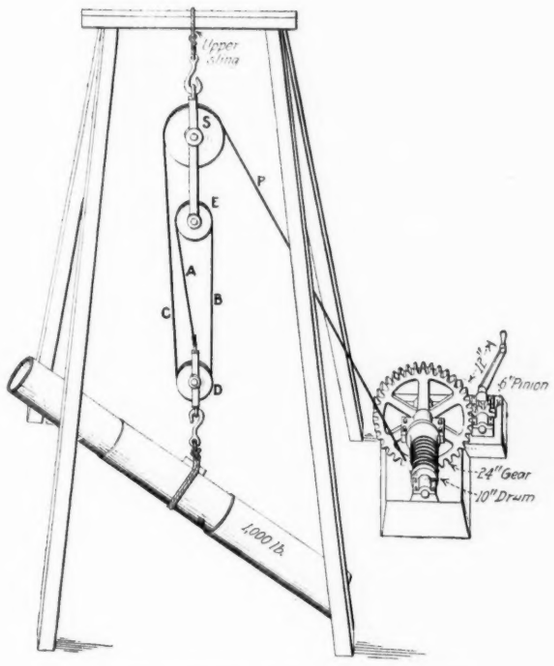
Force Required at Crank Handle of Windlass

Neglecting the weight of tackle, what force would be necessary to be exerted on the crank handle of a geared windlass to raise a stack weighing 1,000 lb.; also to hold it clear of the ground with a rope and sheave gearing ABCDE shown by the sketch, where the drum of the windlass is 10 in. in diameter, drum shaft gear 24 in. in diameter, crankshaft pinion 6 in. in diameter, and crank 12 in. long, where the friction of motion or of rest of the ropes and sheaves is 10 per cent, and of the windlass 6 per cent; and if the rope P is vertical, what would be the weight on the upper sling? *T. A. W.*

If there were no friction each of the ropes A, B and C would have a stress of ⅓ of the weight, or a pull of 333⅓ lb., and the pull required on the drum rope P would be 32[illegible] lb. If the friction is 10 per cent, then for raising the weight would require a pull on P of $333.3 \div 0.9 = 370.3$ lb.; and if the friction of rest is 10 per cent, to hold the weight clear of the ground would require a pull on P of $333.3 \times 0.9 = 300$ lb.

If there were no friction on the windlass with a 10-in. diameter drum, 24-in. diameter gear on the drum shaft, 6-in. diameter pinion on the crankshaft, and 12-in. radius of crank, the tangential force required to balance one pound at the crank handle would be $(10 \times 6) \div (24 \times 12 \times 2) = 0.1042$ lb.

In raising the weight with 6 per cent loss in friction, one pound pull on the rope P would require a tangential effort of $0.1042 \div (100 - 0.06) = 0.1108$ lb.; and for raising the weight, requiring a pull on P of 370.3 lb.,



Force required to raise or hold load

the tangential force at the crank handle would be $370.3 \times 0.1108 = 41$ lb.

If 6 per cent of the load at rest is held by friction of the windlass, then each pound pull on P would be held by a tangential force on the crank of $0.1042 \times (1.00 - 0.06) = 0.0979$ lb.; and for holding the weight requiring a pull of 300 lb. would require a tangential force on the crank handle of $300 \times 0.0979 = 29.38$ lb.

With the rope P vertical the vertical stress on the upper sling would be the weight 1,000 lb., plus the vertical pull on P in either case; that is, for raising the weight, the vertical stress would be $1{,}000 + 370.3 = 1370.3$ lb.; and for holding the load clear of the ground, the vertical stress would be $1{,}000 + 300 = 1{,}300$ pounds.

A new slant on things observed in and out of the power plant

What Happens and Why?

Interest and Depreciation

WHEN you deposit your savings in a bank, the bank is in effect borrowing the money from you. To induce you to make this loan, the bank pays you "interest," perhaps 4 per cent. Only one thing can lead the bank to pay this interest for the use of your money. That is that it in turn can loan it to someone willing to pay more than 4 per cent for the use of it. This third party generally has in mind the purchase of lands, buildings or equipment for use or resale, or the payment of wages and salaries. In any case his motive for borrowing is the hope of a yield exceeding the amount he must pay the bank.

Interest Is Rent Plus Risk

Interest really involves two separate items. One is simply a "rental" to compensate the creditor for giving up the enjoyment or earning power of the things he could have bought with the money loaned. The other element is compensation for a chance that exists or is believed to exist that something may happen to reduce future interest payments or impair the capital itself. This estimated risk largely accounts for the difference in interest between good bonds and speculative stocks.

Where one puts money into another's established and well-operated business, he is generally willing to accept from 6 to 8 per cent, the excess over 4 or 5 per cent representing his evaluation of the slight risk that must exist even in the most stable business.

This brings us around to the expenditure of money for construction and improvements in isolated power plants. Perhaps a growing load demands enlarged capacity, or it may be that while the present capacity is sufficient, new equipment promises reduced fuel or labor costs or better service. A wise decision in such matters can be made only by balancing the estimated savings against the estimated cost. Incidentally, the estimates should, of course, be as reliable as possible.

Two points are self-evident. One is that the plan decided upon should show an appreciable net saving, that is, the gross saving should exceed the cost. The other is that all reasonably possible combinations of equipment should be investigated to make sure that the one selected shows the largest possible net saving. Too frequently, there is a tendency to follow precedent blindly without giving due consideration to all the existing possibilities.

It may be true, as often pointed out, that the power and heat cost is only about 10 per cent of the total cost of conducting the average manufacturing business. Yet if the net profits of the business amount to 10 per cent of the total cost, a cut of one-third in net power cost will increase the net profits of the business one-third. When one is working on a close margin, every little saving is a clear addition to profits, where it appears as a relatively large amount.

The question now arises, "How can the cost be figured?" This article will be confined to the cost of ownership, consisting mainly of interest, depreciation and insurance. If a piece of equipment costs $1,000 installed, including the cost of space needed to house it, it is obviously unreasonable to charge this whole investment against the year's operation. Yet this cost must somehow be allowed for. The standard method involves the idea that all the money spent must be borrowed. Whether it is actually borrowed or not makes little difference, because if the firm sinks its own money in the plant it loses the opportunity to be earning that much interest on the same amount, which could be loaned elsewhere at substantially the same interest rate.

How Cost Is Spread Over Life of Equipment

So we will assume that the owner of the business goes out and borrows $1,000. His credit and business being reasonably well established, he gets the money for 7 per cent, say. Note that he has not put in a cent of his own money at the start. So long as his credit stays good, a payment of $70 (7 per cent) each year will keep the money or whatever he has bought with it in his possession.

But this does not tell the whole story. The day must come when the machine he has bought will become unserviceable for one reason or another. When that day arrives he will be in debt $1,000 with no property to show for it. This loss must somehow be charged off on a yearly basis along with the $70 interest. He estimates, let us say, that the equipment will be serviceable for fifteen years. Dividing $1,000 by 15 gives $66.66. If he were to put this amount into a stocking each year for fifteen years, he would have at the end of the period $1,000 in cash. With this he could go to his creditor and pay off his debt or he could buy another machine equivalent to the first. In either case he would be out no new money. This process could be continued indefinitely.

However, no business man would put money in a stocking. He would invest it at as high a rate of interest as he could obtain with safety. This rate should be practically the same as he himself must pay on borrowed money—in this case 7 per cent. The money might actually be placed out at interest or it might be kept at work in his own business.

The problem now is to figure what sum of money laid away at 7 per cent compound interest each year would total $1,000 in fifteen years. While this can be taken directly from tables prepared for the purpose, the simple theory involved in figuring it is worth understanding. One method would be to lay aside one doller each year and compare the amount accumulated in 15 years with $1,000.

The first dollar would accumulate compound interest[1] for 15 years, at the end of which period it would total $2.76. The second would grow for 14 years to a total of $2.58 and so on for the thirteen other payments. The grand total at the end of 15 years would be $25.13, which goes into $1,000, 39.80 times. So it is evident that if the yearly deposit were $39.80 instead of one dollar, the "sinking fund" would amount to the necessary $1,000 in 15 years. The yearly cost of ownership would then be $70 plus $39.79 plus taxes and insurance.

After making any allowance for the changes in cost of labor and maintenance, the total cost is subtracted from the gross saving to get the net saving. It is this net saving which is the main factor determining the advisability of any given installation.

Effect of Neglecting Interest

The accompanying table gives the actual percentage of depreciation for various lives and interest rates. For 7 per cent and 15-year life the rate is $3.98 per cent, or $39.80 per thousand, as just figured. If compound interest had not been allowed, the yearly depreciation cost would appear to be $66.66 as already pointed out. The difference for long periods is too important to neglect.

RATE OF DEPRECIATION
(Per cent of first cost)

Useful Life, Years	Rate of Interest, per Cent					
	0	4	5	6	7	8
2	50.0	49.0	48.8	48.5	48.3	48.1
4	25.0	23.6	23.2	22.9	22.5	22.2
6	16.7	15.1	14.7	14.3	14.0	13.6
8	12.5	10.9	10.5	10.1	9.74	9.40
10	10.0	8.33	7.95	7.58	7.23	6.90
15	6.67	4.99	4.63	4.30	3.98	3.68
20	5.00	3.36	3.02	2.72	2.44	2.18
25	4.00	2.40	2.09	1.82	1.58	1.36
30	3.33	1.78	1.50	1.26	1.06	0.88

The practice of estimating depreciation rates by dividing the cost by the life is often excused on the basis that the life itself is nothing but a guess, so that such a refinement as allowing for compound interest is not warranted. In the case just considered the actual depreciation rate for fifteen-year life is the same as that figured by simple division for a twenty-five-year life. Ten years is worth considering.

In the case of short-lived equipment, on the other hand, the interest is of relatively little importance. For a six-year life the depreciation rate is 16.7 per cent neglecting interest and 14.0 per cent at 7 per cent interest.

[1]It is assumed that interest is compounded annually. Compounding semi-annually or quarterly would make a slight difference.

New and Improved Equipment

New Synchronous Motor for Compressor Drives

Single-cylinder double-acting compressors or two-cylinder single-acting compressors require much greater flywheel effect than a two-cylinder double-acting compressor of the same capacity and speed. In the smaller compressors, requiring some 20- to 100-hp. motors, the compressors are usually single-cylinder double-acting or two-cylinder single-acting, and it is becoming standard practice to mount the motor directly on the end of the compressor shaft in substantially the same manner that a pulley would be mounted. In such an installation, particularly with ammonia compressors, it is often inconvenient to provide a separate flywheel and it is, therefore, desirable to have all the flywheel effect in the rotor of the motor.

Placing all the weight necessary in the spider of the rotor as usually constructed, throws excessive weight on the compressor bearing and occupies more space than is available.

A new solution for this problem is found in the special synchronous motor recently put on the market by the Electric Machinery Manufacturing Co., of Minneapolis, shown in Figs. 1 and 2.

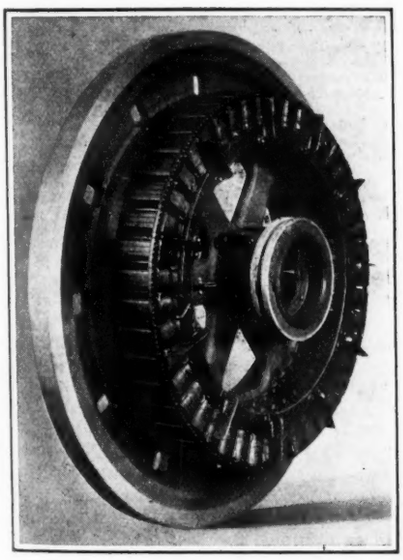


Fig. 1—Polepieces are bolted to a flange cast on the flywheel

The construction uses a standard synchronous motor stator with a special rotor having a flywheel rim a little larger than the stator outside diameter. Thus the rotor becomes a flywheel with a flange on one side, on which is mounted a standard set of polepieces. This construction, with a given weight of rotor, gives about double the flywheel effect that can be obtained by the usual construction. The rotor spider with flywheel is cast in one piece with a split hub, standard polepieces being bolted to the flange in the usual manner.

The flywheel constitutes a guard for the back end of the stator coils. Openings at *AA*, Fig. 2, provide centrifugal blower ducts furnishing ventilation to the stator and field coils. Openings at *B* permit inspection of the air gap and additional ventilation, also serving as pinch pockets for adjusting the compressor. This construction occupies no greater space than was occupied by the standard motor with about half the flywheel effect.

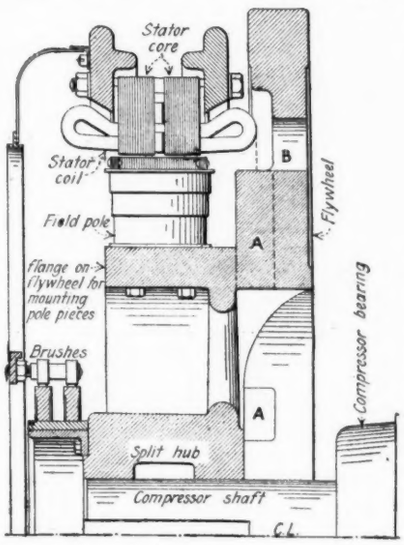


Fig. 2—Section through new synchronous motor

Non-Sticking Valves for Caustic Solutions

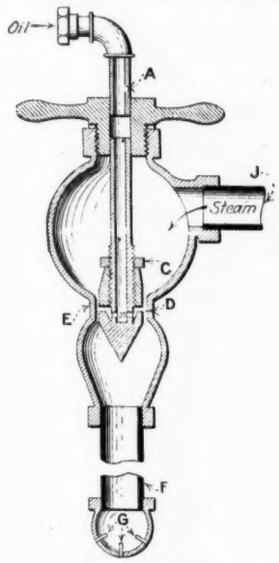
The difficulties of stopcocks sticking when used in systems handling caustic solutions has been solved by the General Electric Co. by the use of Genelite as a facing for the rotating part of the valve. Among the properties of the material are that it never seizes or flows and that it is self-lubricating to a certain extent.

Considerable trouble was experienced with valves in the oxygen and hydrogen producing plant of the company. Valves stuck, and needed to be disassembled and sometimes destroyed after they had been used in caustic systems. Valves with Genelite facings were found to operate freely after 18 months of service. Such units can be used with practically any solution that will not attack bronze.

Genelite is a synthetic bronze, having uniformly distributed throughout its mass approximately 40 per cent by volume of very finely divided graphite. It was developed in the research laboratory of the General Electric Co. a few years ago as an improved bearing alloy. Although the material has the appearance of bronze, it is machined with difficulty; it can, however, be ground easily. High pressure and heat are used in molding it.

Low-Pressure Steam-Atomizing Oil Burner

A new type of low-pressure steam-atomizing oil burner, the invention of a practical oil-refinery man, has been been placed on the market by George W. Walsh & Co., Engineers, 16 Rawston Road, Roslindale, Mass. The design arose out of a need for a burner to operate with low-pressure steam and handle a variety of refinery waste. Referring to the accompanying cross-section, oil enters *A* at 200 lb. pressure, passes through the ¼-in. threaded pipe to the cones *D*. With the aid of locknut *C* these can be adjusted to make a circular slot of variable thickness. Steam enters at *J* and sweeps through the venturi neck *E*, picking up and atomizing the disk-like oil jet. The atomized mixture is carried through *F* to the burner tip inside of the furnace. The drawing shows two slots, *G* and *H*. These are located to meet the particular needs of the furnace in which the burner is installed. It is claimed that a single burner can handle evaporations ranging from 1,500 to 30,000 lb. of steam per hour, with steam pressures at the burner ranging from 7 to 35 lb.



Walsh Oil Burner

Comparison of Actual Performance and Theoretical Possibilities of the Lakeside Station*

By M. K. DREWRY
Technical Engineer of Power Plants, The Milwaukee Electric Railway & Light Company

This Paper Reports an Analysis of Operation at the Lakeside Station of The Milwaukee Electric Railway & Light Company, in Which Actual Results Are Compared with Those Theoretically Possible for the Period from October 10 to November 10, 1924

THE calculations of Table I show that less than 5 per cent (see item 10) need be added to the best theoretical performance of the station to obtain its heat consumption under actual operating conditions. In terms recently introduced, its "operating efficiency ratio" is approximately 95 per cent.

Of the 5 per cent difference about ¼ per cent can be attributed to uneconomical boiler loading, 2 per cent to banking and starting cold boilers, 1 per cent to uneconomical loading and starting of turbines, and the remainder to unusual operations and miscellaneous losses. The theoretical plant efficiency calculations allow 2.2 per cent for radiation and miscellaneous losses, a large share of which is constant regardless of the load carried.

TABLE I—COMPARISON OF THEORETICAL POSSIBILITIES AND ACTUAL PERFORMANCE

	Per cent
Most Economical Loading	
1 Boiler efficiency (computed from losses)	91.6
2 Turbo-generator efficiency ratio (from tests)	76.2
3 Consumption of auxiliaries	
Electrical auxiliaries (from meters)	4.25
Steam (credit given for heat return to condensate; taken from operating data)	1.84
4 Coal drying (from operating data)	0.25
5 Radiation and miscellaneous losses (by difference to equalize items 14 and 15)	2.2
6 Efficiency ratio,[1] most economical loading	64.0
Losses Attendant with Actual Operation (Calculated from Operating Data)	
7 Boiler room	
Uneconomical loading of boilers	0.25
Banking and starting cold boilers	1.98
8 Turoine room	
Uneconomical loading	1.75
Starting	0.26
9 Unusual operations	
Entire plant	0.22
10 Total operating losses	4.49
11 Calculated efficiency ratio, average operating conditions	61.1
12 Theoretical cycle efficiency (Marks and Davis tables)	35.4
13 Calculated plant thermal efficiency	21.6
	B.t.u. per kw-hr.
14 Corresponding calculated heat consumption	15,800
15 Actual plant heat consumption	15,800

[1] A measure of equipment efficiency. Actual boilers, turbines and auxiliaries have a combined efficiency of 64 per cent that of perfect equipment.

The turbo-generator efficiency is a weighted value derived from the test results, averaging the Rankine-cycle efficiency ratio (Marks & Davis steam tables) of the four units installed and operated during the time considered. As previously inferred, no steam extraction operation occurred during the period under consideration. The efficiency ratio recorded includes generator losses and excitation energy.

Table III shows the division of energy to the auxiliaries. Credit for heat returned to the condensate by exhaust steam from the auxiliaries has been allowed.

The plant heat consumption for the period considered averaged 15,795 B.t.u. per kw.-hr. The average proximate analysis of coal during the period considered was as follows:

	Per Cent
Volatile matter	31.4
Fixed carbon	59.4
Moisture	4.02
Ash	9.2
Sulphur	1.1
B.t.u. per lb. as received	13,141
B.t.u. per lb. dry	13,691

The corresponding ultimate analysis shows the following:

	Per cent
Sulphur	1.1
Hydrogen	4.95
Carbon	78.0
Oxygen	6.6

To encourage economy in the use of coal, steam and electricity, all operators of the station are paid a percentage of the saving they effect in excess of a predetermined standard. Calculation of the standard station efficiency is made each month, and all operators are paid 45 per cent of the actual coal saved above the standard set. The bonus paid has varied from 8 to 15 per cent of the stipulated wages, since the system has been inaugurated.

TABLE II—HEAT BALANCE

	B.t.u.	Per cent.
Heat per lb. of coal	13,691	100.00
Loss due to moisture in coal	26	0.19
Loss due to moisture from hydrogen	487	3.55
Loss due to moisture in air	10	0.07
Loss in dry chimney gases	453	3.31
Loss due to incomplete combustion of carbon	68	0.5
Loss due to unconsumed hydrogen hydrocarbons	0	0
Loss by radiation and unaccounted for	103	0.78
Heat absorbed by boiler, economizer and superheater	12,544	91.6

Constant watch has permitted the setting up of standards that maintain plant efficiency. For one thing, a standard of five cubic feet per minute per condenser has been set for air leakage. Again, turbine loading is given careful attention. Except during peak and low load periods, the 30,000-kw. units are kept accurately at their most economical loads by making the overload valve gear inoperative by means of a special handwheel.

Among the conclusions that may be drawn from this study are the following:

A modern power station may be so designed and operated that its ultimate efficiency will be within 5 per cent of the combined efficiency of its component equipment working at the most economical load. The combination of boilers, turbines and auxiliaries, allowing for radiation and miscellaneous losses, may work at an efficiency ratio of 64 per cent in a pulverized-fuel station. This percentage multiplied by the thermal efficiency of the cycle employed and by 95 per cent operating efficiency ratio, should give the approximate ultimate over-all thermal efficiency of any pulverized-fuel station having the usual equipment.

TABLE III—DIVISION OF ENERGY TO AUXILIARIES

A—Electrical Auxiliaries	Per cent
1 Station lighting	0.1
2 Coal handling:	
Car dumper	0.0006
Magnetic pulley	0.006
Crushers	0.02
3 Preparation house:	
Conveying green coal	0.003
Pulverizing	1.08
Conveying pulverized coal	0.025
Total	1.110
4 Boiler room:[2]	
Induced-draft fans	0.50
Coal-feeder motors	0.08
Primary air fans	0.25
Boiler-feed pumps	0.62
Air compressor, machine shop, etc	0.25
Total	1.65
5 Turbine room:	
Circulating pumps	0.88
Hotwell pumps	0.29
Air removal (on one unit)	0.17
House service andiscellaneous	0.03
Total	1.37
Total energy for electrical auxiliaries	4.25
B—Steam-Driven Auxiliaries	
1 Boiler room:	
Exhaust heat reclaimed:	
Boiler-feed pumps	1.24
Induced-draft fans (one boiler)	0.02
House service pump	0.01
Exhaust lost:	
Steam jets on burners	0.01
Boiler soot blowers	0.2
Economizer soot blowers	0.43
Superheater soot blowers	0.31
Ash conveyors	0.4
2 Turbine room:	
Steam-jet air pumps	0.36

[2] Estimated from tests.

The banking losses of a pulverized-fuel station, operating at 65 per cent load factor, may be limited to 2 per cent. The energy cost of pulverizing coal was 1.1 per cent and that of conveying and pumping it before and after pulverization was almost negligible.

*Paper presented at the Milwaukee spring meeting (May 18-21) of the A.S.M.E.

Suggested Rules for the Care of Power Boilers*

Proposed as an addition to the A. S. M. E. Boiler Construction Code

IT IS the request of the Committee that these proposed rules be fully and freely discussed so that it may be possible for any one to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be considered by the Boiler Code Committee.

A. S. M. E. Boiler Construction Code

Section VII

PREAMBLE

THESE rules, used in connection with steam boilers constructed in compliance with Section I of the A.S.M.E. Boiler Construction Code and for operation at a steam pressure exceeding 15 lb. per sq.in. above atmospheric pressure, will lead to safety in the use of steam boilers.

These rules are compiled to assist operators of steam boiler plants in maintaining their plants in as safe condition as possible, the subject of economy receiving only incidental consideration.

The difficulty in formulating a set of rules that may be applied to all sizes and types of plants is recognized; therefore these rules are suggestive only and it may be advisable to depart from them in certain cases.

DESCRIPTION OF SECTIONS

I. *Rules for Routine Operation.* These rules are elementary and govern the proper procedure in performing the ordinary duties of operating and maintaining steam boilers.

II. *Rules for Operating and Maintaining Boiler Appliances.* These rules are also elementary in character and are classified to give collectively all rules pertaining to any one boiler appliance, it being impracticable to include some of these rules in Section I.

III. *Rules for Inspection.* These rules apply only to those who are responsible for the operation of boiler plants and must not be considered as applying to the state, municipal, or insurance companies' inspectors. Consideration should be given to the importance of continual inspection as compared with periodical inspection.

IV. *Rules for the Prevention of Direct Causes of Boiler Failures.* These rules are intended as a guide and assistance to those who desire to make a more comprehensive study of the care of steam boilers in service. Their scope, including the entire boiler plant, is wider than that of Sections I and II. These rules are divided into two major subdivisions: Overpressure and Weakening of Structure. The rules on Overpressure deal with conditions which may cause boiler failure by subjecting the boiler to stresses greater than those for which it was designed. The rules on Weakening of Structure deal with conditions which may cause boiler failure by weakening the boiler structure to such an extent that it cannot withstand the stresses for which it was designed.

V. *Partial Rules for Installation.* These rules are not complete. They treat with some conditions which are not encountered in the Rules for the Construction of Power Boilers.

Appendix — Feedwater Analysis, Treatment, and Control. The Appendix contains approved methods of investigating and reporting of analysis, treatment, and control of feedwater with the intent of standardizing methods and forms. It is not intended so much for the operating engineer as for those specializing in the chemistry of feedwater.

Respectfully submitted,

F. M. GIBSON, *Chairman*	S. F. JETER
	W. H. LARKIN, JR.
E. C. BAILEY	M. F. NEWMAN
W. G. DIMAN	CYRUS WM. RICE
V. M. FROST	J. S. SCHUMAKER
J. R. GILL	H. F. SCOTT
J. W. HAYS	N. STAHL

Rules for the Care of Power Boilers

I—Rules for Routine Operation

PUTTING BOILERS IN SERVICE

Getting Up Steam

C-1. If the boiler is new or has been out of service for an extended period or has been opened for cleaning or repairs, examine the inside of the boiler and make sure that it is free from tools and foreign matter and that there is no one in the boiler; then close the manhole openings. In case of a new boiler, boil out for a few hours by the method given in Par. C-42.

C-2. See that the combustion chamber and gas passages are clean and in good repair, and that all clean-out doors in setting fit properly and are closed tight.

C-3. Operate both inlet damper and outlet damper and make sure that they are free and in good condition. Leave the inlet and outlet dampers open. Operate the stoker and draft fan to see that they are ready for service. Make sure that the grates are satisfactory and in place.

C-4. See that the blowoff valves, water column and water-glass drains, gage cocks, and feed valves are in good working condition and closed. Open a vent valve.

C-5. Fill the boiler to such a level that the rise in level due to the steam generation will bring the water level to its normal position when full working pressure and flow of the steam have been reached. Close feed connections. Where auxiliary feed connections are installed, they should be used in filling the boilers as a means of testing their condition. Open and close gage cocks and blow-down valves on water column and water glass in order to make sure that these connections are free and clear.

C-6. See that the cock to steam pressure gage is open. Examine the safety valves as far as practicable to see that they are in working order.

C-7. Ease up on the stem of the main steam stop valve, slightly lifting the valve off the seat in order to make sure that the valve is not stuck.

C-8. If coal is used as fuel, cover the grate with a thin layer of coal and start a light fire with live coals from adjacent boilers, with wood or other light combustibles. Do not use any combustibles for igniting a coal fire in such a manner as to cause excessive smoke or possible flareback. Where pulverized coal, gas, or oil is used as fuel, make sure that outlet damper is open to create a light draft before introducing and igniting fuel.

C-9. If oil is used as fuel and the system is new or has been out of service for a considerable period, first clean and examine the strainers and remove, clean, and examine tips and burners. If compressed air is available, blow out the oil supply lines with air. Place and adjust burners and tips and work the air registers to see that they are in good working condition. Close individual burner throttle valves. Test the steam coils in the heater for oil leakage by keeping the maximum allowable head of oil on the heater, with the steam pressure shut off. Hold this head of oil on the heater in excess of 15 minutes. Next, unseat the steam valve on the coil with the drip valve wide open. Collect the condensate from the drip and examine for oil.

C-10. Remove any spilled oil about burners, fronts and floor and see that there is no oil on the floor of the combustion chamber. Ventilate the boiler by opening draft gates and dampers.

C-11. If no steam is available for oil pump and burners, raise steam in boiler by wood fire. Remove any excess accumulation of water in the oil tank. See that oil pumps are warmed up ready for use and that relief valves are properly set. Open suction-line valves and pump oil to burners. If oil lines are equipped with air chambers, charge them with compressed air. Examine oil lines and equipment for leaks.

C-12. Light the center burner by holding a hand torch near and just under tip of burner then turning on the oil and stand well clear to avoid possible flareback. If the torch is snuffed out before the oil is lighted, shut off the oil and relight the torch. Always use the torch for lighting burners until the brickwork is intensely hot, and even then if all burners are out. Next light the adjacent burners, but be sure that there is an excess of draft before lighting additional burners. Do not allow the oil to impinge excessively on the brickwork or parts of the boiler.

C-13. After lighting the fire, maintain a light fire until the brickwork of the setting is dried out thoroughly. If the entire setting is new, the drying out may require several days; if the lining of the combustion chamber only has been renewed, about 48 hours will be sufficient time for drying out for small settings. Larger ones will require a longer time. After the usual week-end shutdown, a light fire should be carried for about one hour. Only in extreme emergency should steam be raised in less than one-half hour, even with water-tube boilers.

C-14. After the water becomes heated, check the level of the water in the water glass with gage cocks and examine blowoff valves for leaks. After steam has escaped through the vent valves for a few minutes, close the valves.

*Reprinted from *Mechanical Engineering* for May, 1925. On account of the length of the rules *Power* is printing them in short installments, of which this is the first. The rules were presented at a public hearing at the A.S.M.E. Spring Meeting in Milwaukee.

C-15. After the brickwork is dried out and the boiler heated, begin raising the steam pressure slowly, especially in internally fired boilers where the circulation is sluggish. Keep the water level in sight. When the steam pressure approaches the working pressure and before cutting the boiler into service blow the water down to the proper level if necessary. Examine the boiler for leaks and test the safety valve or valves by hand, holding the valve or valves open for a short period to blow out possible accumulation of dirt or chips. On high-pressure boilers the safety valves should be popped well before the steam pressure approaches the working pressure.

Cutting In

C-16. Before cutting in a boiler, open and leave open until the boiler is on the line, all drains in the connections between the boiler and the main header, especially the open drains between the two stop valves. In general, in cutting in a boiler to a steam header already in service, the steam line between the boiler and the header is usually warmed up by backfeed through the drip line or by means of the bypass valve, and the header valve fully opened and the boiler then allowed to cut itself in automatically with the non-return valve In case a non-return valve is not used, the boiler stop valve should, of course, be opened slowly when the pressure in the boiler and the steam line are approximately equal.

a. With two hand-operated stop valves, open slowly (to avoid water hammer), to full opening, the stop valve nearer the main header. When the pressure in the boiler is nearly equal to the pressure in the main header, open slowly, to full opening, the stop valve nearer the boiler. After opening each stop valve, stand by for a short period prepared to close the valve slowly in case there is any indication of water hammer.

b. With one hand-operated stop valve and one combined stop and check valve, when the hand-operated stop valve is nearer the main header, open it slowly and preferably only a small amount at first. Stand by for a short period to close the valve in case there is any indication of water hammer, then open the valve to full opening. When the pressure of the boiler is still 10 to 50 lb. below the pressure in the header, slowly back off the valve stem of the combined stop and check valve sufficiently from the check to provide full opening of the check valve. In order to insure that the check valve functions properly, always use it automatically for cutting in and cutting out boilers, provided that the main header is filled with steam at full pressure.

c. With one hand-operated stop valve and one automatic non-return check valve, open the hand-operated stop valve slowly when the pressure in the boiler is still 10 to 50 lb. below the pressure in the main header and stand by for a short period to close the valve slowly in case there is any indication of water hammer.

d. If steam is being raised on a boiler not connected to a common steam header, in general it would be more advisable to raise the steam pressure on the whole steam line at the same time, all drips being open.

e. After cutting in a boiler equipped with non-return valves, with two independent outlets, observe the steam pressure in the boiler to make sure that both valves open. If the non-return valve is a combined stop and check valve, operate the rising stem after the steam pressure in the boiler has reached its working pressure, in order to ascertain whether or not the valve has opened properly.

Influence of Cheap Power on National Prosperity*

By C. M. Ripley†

The importance of efficient power plants upon the general prosperity of the country is illuminatingly shown by the train of gears in the illustration.

The manufacturing companies design, build and sell apparatus that is efficient. Because the power plants do use the latest electrical apparatus, they are able to generate power at a low cost. Low electrical rates encourage the factories to use more power. This, combined with automatic machinery, makes the factory more efficient and permits a greater output.

Because of the greater factory output, it has been possible to adopt the eight-hour day and to pay higher wages, at the same time selling the product at a lower unit price. As a consequence people have more money to spend and they are able to buy more of the necessities and luxuries of life, as indicated by wheel 6. The greater consumption of goods creates prosperity for all.

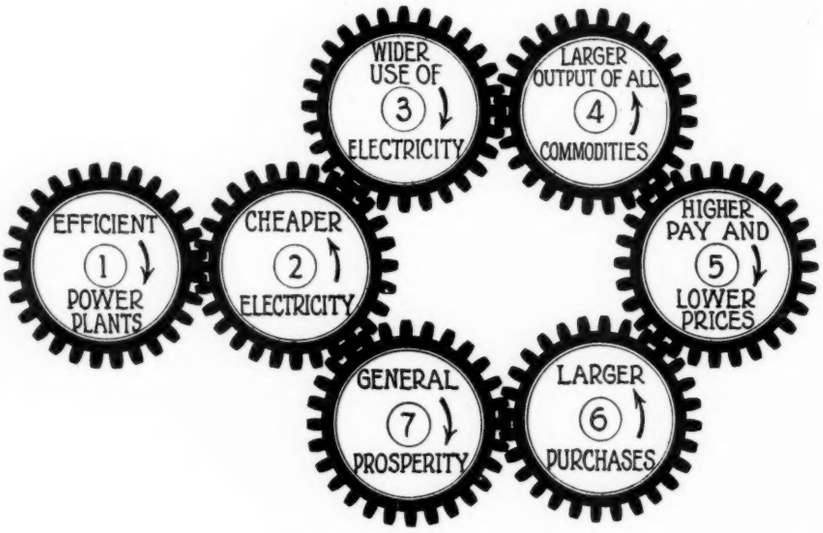
The improvement in machine efficiency has had its effect upon the comparative output of factories. For example, a factory equipped in 1900 cannot compete with a factory fitted with modern machinery. The company that fails to discard the out-of-date and install the latest mechanical improvement, is likely to become bankrupt for the reason that the alert and thoroughly modern competitor can reduce prices below the cost of the less progressive firm.

What is true of firms is also true of nations. People in Europe and Asia use less power and the people have less to spend, less to wear and less to eat. A British economist says that the American workman has three times the prosperity possessed by the Britain.

Going still farther away—witness the rickshaw runners of China and Japan; the men threshing corn and wheat by hand in Egypt and India; those who excavate earth and rocks and carry out the material in baskets, or those in Egypt who lift water in baskets for irrigating purposes.

Compare their pay and their standards of living with that of Americans who use steam and electric shovels, steam and electric pumps, steam and electric cranes, gasoline automobiles, kerosene tractors and modern machinery in factories, mills and mines.

Wherever you see high wages, there you find power-driven machinery; and wherever you find no power-driven machinery, there you find low wages.



The gear train of industry

Large factory pay envelopes do not depend on a generous employer. The eight-hour day does not depend on a kind-hearted boss. What is the main determining factor? It is power and modern machinery.

The man engaged in the power industry is doing his part, not only to increase general prosperity, but to provide mechanical means for lifting loads, carrying burdens and turning wheels that formerly had been lifted, carried and turned by human muscles.

He is helping to emancipate the race from dull drudgery, and he is helping to elevate labor to a higher standard of dignity and a higher standard of living.

Shasta County, Calif.—The Pacific Gas and Electric Co. has applied for a license covering the use of government lands in connection with its Kilare and Cow Creek plants, in Shasta County, Calif.

*Extract of an address delivered before a number of assemblies.

†General Electric Co., Publicity Department.

New 80,000-Kw. Unit for Hudson Avenue Station of Brooklyn Edison Co.

Largest Cross-Compound Impulse-Reaction Unit Will Have Two 1,800-R.P.M. Generators

THE Brooklyn Edison Co. has purchased a Westinghouse cross-compound unit for the fourth turbine-generator in the new Hudson Avenue Station. This unit will be installed in the summer of 1926 and will be the largest built, the capacity being 88,888 kva. with a maximum output of 80,000 kw. The turbine is capable of this capacity when bleeding for heating the feed to a maximum of 360 deg. F. in four stages. The use of machines of this size will result in the station having an ultimate capacity exceeding 550,000 kw., or 630,000 kva., with eight main units installed.

The turbine is to operate at 375 lb. gage, 700 deg. total temperature and 29 in. vacuum, these steam conditions having been adopted instead of continuing the former 265 lb., 200 deg. superheat conditions, in order to take advantage of the economies of the higher steam pressure. The high-pressure element will be of the combination impulse-reaction type with conical blading; the low-pressure will be a double-flow reaction-type element, with warped blade sections inducive to high economy. Each turbine will drive a 44,444-kva. three-phase 60-cycle 13,000-volt generator at 1,800 r.p.m., and the high-pressure element will carry a direct-connected exciter to supply the excitation current for both generators.

When exhausting to a 29-in. vacuum the straight-condensing water rate will be slightly over 9 lb. per kw.-hr. at the most-economical load point of around 51,500 kw. With four-stage bleeding 1 kw.-hr. will be produced with a little under 11,000 B.t.u. supplied to the steam at the best load point, which under these conditions is about 60,000 kilowatts.

Men Being Considered for Power Commission Secretary

As announced recently in *Power*, O. C. Merrill, executive secretary of the Federal Power Commission, has signified his intention of severing his connection with the Federal Power Commission. Inadequate compensation is the reason given.

The names of Dr. F. H. Newell, F. E. Bonner and Paul S. Clapp are being mentioned in connection with the vacancy that will be created when Mr. Merrill resigns as executive secretary of the Federal Power Commission. Dr. Newell was connected with the Reclamation Service from 1902 to 1914, first as chief engineer and later as director. He is a past-president of the American Association of Engineers and has been connected prominently with educational work and the public service. While Dr. Newell has been an advocate of public ownership as a theoretical ideal, he favors only limited application of it.

Mr. Clapp has been an active opponent of public ownership of electric utilities. He is a young man, but his ability is widely recognized. Mr. Clapp was graduated in 1913 from Iowa State College, Ames, Iowa, with a B. S. degree in electrical engineering and later was awarded the professional degree of electrical engineer.

Mr. Bonner, who is the district engineer of the Forest Service with headquarters at San Francisco, has been mentioned as one who has had long experience in the handling of water-power matters for the government. One-third of the Federal Power Commission's projects are in his district.

PRODUCTION OF BITUMINOUS COAL 1919–25

(In Thousand Net Tons)

	1925	1924	1923	1922	1921	1920	1919
January	51,914	52,464	51,909	38,930	41,148	49,748	42,193
February	38,987	47,262	43,610	42,425	31,524	41,055	32,103
March	37,626	41,253	48,411	51,936	31,054	47,850	34,293
Total 3 mos.	128,527	140,979	143,924	133,291	103,726	138,653	108,589
April	.....	30,404	44,028	16,335	28,154	38,764	32,712
May	.....	32,248	47,660	21,005	34,057	39,841	38,186
June	.....	31,433	47,054	23,096	34,635	46,095	37,685
July	.....	33,317	46,678	17,602	31,047	45,988	43,425
August	.....	35,892	50,544	26,755	35,291	49,974	43,613
September	.....	42,340	47,805	42,463	35,870	50,241	48,209
October	.....	48,373	50,869	46,733	44,687	53,278	57,200
November	.....	42,066	44,387	46,900	36,805	52,576	19,006
December	.....	46,228	41,208	48,088	31,650	53,257	37,235
Total—Year	.....	483,280	564,157	422,268	415,922	568,667	465,860

Source: U. S. Geological Survey.

Always Put Return Address On All Mail Matter

With a view to economy and the elimination of great waste, Postmaster New has directed that an intensive campaign be waged during the first week of June to educate the public in regard to better mailing practice. The most important reform desired is that the writer of a letter or a post-card or the sender of a package put a return address on it. A vast sum could be saved if senders would use the street and number in the address and also put their own name and address on the outside of letters and bundles.

Lock Gates and Switchboard at Shoals Unfinished

Construction work at Muscle Shoals has reached the cleaning-up stage. The masonry work of the dam, the lock and the power house have been completed with the exception of a small amount of work around the last four water-wheels installed and the switchhouse.

The main spillway gates have been installed and the machinery for their operation is practically ready. The work still to do is in connection with the installation of the switchboard and the switching apparatus and lock gates. The latter two pieces of work are under contract.

William McClellan, one of the members of the President's Muscle Shoals Commission, spent last week familiarizing himself with the project.

W. L. Abbott Nominated for A.S.M.E. President

The Nominating Committee of the A.S.M.E. presented the following nominees for the offices of the society for the next year: President, William L. Abbott, chief operating engineer, Commonwealth Edison Co., Chicago, Ill.; vice-presidents, A. G. Christie, professor of mechanical engineering, Johns Hopkins University, Baltimore, Md., William T. Magruder, professor of mechanical engineering, Ohio State University, Columbus, Ohio, Roy V. Wright, managing editor *Railway Age*, editor *Railway Mechanical Engineer*. New York, N. Y.; managers, Robert L. Daugherty, professor of mechanical and hydraulic engineering, California Institute of Technology, Pasadena, Calif., William Elmer, superintendent, middle division, Pennsylvania Railroad Co., Altoona, Pa., Charles E. Gorton, chairman, American Uniform Boiler Law Society, New York City; treasurer, Erik Oberg, editor *Machinery*, New York City.

Hoover Tells of Waste in Government and Urges Reorganization

United States Chamber of Commerce Holds Thirteenth Meeting

AT THE thirteenth annual meeting of the Chamber of Commerce of the United States, which was held in Washington, May 21-23, important pronouncements were made by Henry W. Robinson, of Los Angeles, member of the Dawes Committee, and Julius H. Barnes, former president of the United States Chamber of Commerce, to the effect that the hope of creating a sufficient volume of exchange to transfer reparation credits out of Germany lies in plans for using German products in the development of backward countries.

An address by W. E. Humphrey, new member of the Federal Trade Commission, set forth the new items in the Commission's policies, which are briefly: Publicity not to be given to a complaint before trial; evidence, papers, etc., to be held confidential; unfair practices as between business corporations where no public interest is involved not be taken up by the Commission: trivial cases not to be considered.

Secretary of Commerce Hoover gave a straight talk on "Waste in Government," which was inspiring. Some of his statements were:

"Officials of the government as now organized are legislators, judges, policemen, prosecutors and juries rolled into one. The time has come, when every single department, bureau and board in the entire government should be placed upon the operating table and a clean-cut separation established between semi-judicial and semi-legislative functions on the one hand and administration on the other.

"It is not necessary, that each of these groups should become a whole executive department, each under a Cabinet officer, but it is entirely feasible to place them under the supervision of a special Assistant Secretary; and if we were truly intelligent we would class him as an expert and outside selection on political grounds.

"Over many years our people have been striving to better the federal administration. We have succeeded in two major steps; we still have a third equally important and perhaps more difficult to accomplish. The first was the establishment of government based upon merit. The second was the establishment of adequate control of appropriations through the Budget System. There still remains the third and even greater but more obscure waste—that of faulty organization of administrative functions. And the first two steps will never reach the full realization without the third."

Mr. Hoover went into the faults of the administration organization in some detail. His concluding remarks were briefly:

"What we need is three primary reforms: First, to group together all agencies having the same predominant major purpose under the same administrative supervision; second, to separate the semi-judicial and the semi-legislative and advisory functions from the administrative functions, placing the former under joint minds and the latter under single responsibility; and third, we should relieve the President of a vast amount of direct administrative labor.

"Nor will we ever attain this until Congress will authorize the President or some board, if you will, or a committee of its own members, to take the time to do it. Congress courageously removed the Civil Service from politics; it created the Budget, it established the Classification. The remaining great step is to authorize the reorganization of the administrative arm of the government.

"I do not expect that the federal government will ever be a model of organization, but I have aspirations to see it improve. Someone has said that the first ten years in any needed reform are the hardest. The first ten years are up."

Macy's Power Plant Saves $100,000 Yearly

THAT Macy's department store —one of the largest in New York City—saved $100,000 during 1924 by generating its own power was the message prominently displayed in one of its Broadway show windows last week. This saving was offered as "another reason why Macy's prices on all merchandise are 6 per cent. less." Other features of the display, which incidentally advertised a show of electrical appliances on the eighth floor, were graphic illustrations of the amount of power consumed and models and pictures of the power equipment. This method of tying the isolated plant into the advertising of a department store is of such interest to engineers similarly situated, that it is planned to devote a page in the next issue to a picture of the exhibit with more extensive comments.

Requirements for Boiler Plant Operations

A committee of engineers working in connection with the steam engineering department of the Cass Technical School, Detroit, Mich., has recently arranged an outline of knowledge and information (job analysis) which should be given in a course for prospective boiler operators of 100 per cent ability. The general heads are: Kinds of work; knowledge of equipment; knowledge of materials; tools; general knowledge; mathematics; mechanical drawing; knowledge of processes; knowledge desirable.

Copies of this outline may be had from Cass Technical High School, Detroit, Mich. It is desired that constructive criticism from all men engaged in engineering work be obtained, and all such criticisms will be welcomed and carefully considered by the committee.

A.I.E.E. Elects Officers for 1926

Dr. Michael I. Pupin, professor at Columbia University, and well known throughout the world as a scientist, was elected president of the A.I.E.E. at the annual business meeting held in the Engineering Societies Bldg., New York, May 15. Other officers elected were: Vice-presidents — Arthur G. Pierce, Cleveland; W. E. Mitchell, Birmingham; Herbert S. Sands, Denver, (reelected); P. M. Downing, San Francisco; W. P. Dobson, Toronto, Canada. Managers—M. M. Fowler, Chicago; E. C. Stone, Pittsburgh; H. A. Kidder, New York. Treasurer—George A. Hamilton, Elizabeth, N. J. (reelected).

Headwater Improvement Costs Not Under Water Power Act

Assessment of the costs of headwater improvements or beneficiaries of the government, including federal licenses, in no way concerns the Federal Power Commission. The question has been under discussion in connection with the Sacandaga Lake reservoir project, which will benefit the Ford project at Troy, as well as various cities and towns on the Hudson.

In the opinion of O. C. Merrill, the executive secretary of the Federal Power Commission, this matter comes in no way within the purview of the water-power act. States may not make assessments against the federal government, but no such point is involved in assessing a privilege that the federal government has extended to a licensee. The government in this instance has no more authority than it would have to pass upon the other taxes that the state may levy on a licensee.

Franklin Medal Presented to Elihu Thomson

Prof. Elihu Thomson was awarded the Franklin medal and a certificate of honorary membership in the Franklin Institute on May 20.

Professor Thomson has taken out more than 600 patents, and his inventions in dynamo-electric machinery, electric welding, watt-hour meters, lightning arresters and magnetic arc extinguishers are deemed fundamental. He is now and has been for many years connected with the managing corporation of the Massachusetts Institute of Technology, and was one of the founders of the American Electric Co. which later was merged with the General Electric Company.

In 1889 he was president of the A.I.E.E. and was the first recipient of the organization's Edison medal. He has been awarded the John Fritz medal of four national engineering societies, the Kelvin medal, which was presented to him at the World Power Conference on July 11, 1924, the Hughes medal of the Royal Society of London, the Rumford medal, the Elliott Cresson gold medal by the Franklin Institute and twice the John Scott legacy medal and decorated by the French government.

Stokers Sold During Four Months of 1925

Reported by Department of Commerce

Year and Month	Establishments Reporting (Num.)	Stokers Sold (Number)	Installed Under Fire-Tube Boilers: Number	Installed Under Fire-Tube Boilers: Sq.Ft. Heating Surface	Installed Under Water-Tube Boilers: Number	Installed Under Water-Tube Boilers: Sq.Ft. Heating Surface
1925						
April.....	13	120	23	58,930	97	417,340
March.....	13	131	17	24,460	114	686,530
February...	13	135	28	49,050	107	413,930
January....	13	57	4	8,700	53	270,010

Navy Has New Small Engine for Shipboard Planes

A new design small air-cooled engine for use in small airplanes for shipboard use has been developed by the Navy and has lately passed its block tests. This engine develops 80 hp. at 1,800 r.p.m. and weighs only 208 lb., or 2.6 lb. per horsepower. It has been built and tested under Navy Department specifications, by the Kinney Manufacturing Co., Boston, Mass. In order to obtain a small engine of such light weight, it was necessary to introduce a number of novel features.

The engine is a static-radial having five cylinders. The usual push-rod construction for actuating the valves has been eliminated and in its place has been substituted a hydraulic valve gear utilizing the lubricating oil.

Eagle River, Colo., Power Possibilities

An engineering report prepared by E. E. Jones of the Geological Survey shows that the potential power of Eagle River, Colo., below Red Cliff amounts to 28,000 hp. for 50 per cent of the time and 13,500 hp. for 90 per cent of the time, whereas only 325 hp. is now utilized. The total fall of the river from Red Cliff to its mouth, a distance of 53 miles, is 2,440 ft., practically all of which could be utilized in 14 proposed water-power plants.

This illustrated manuscript report containing a plan and profile of Eagle River and describing its water-power resources may be consulted at the office of the Geological Survey at Washington, D. C., or at the district office of the Survey at 403 Federal Building, Denver, Colo.

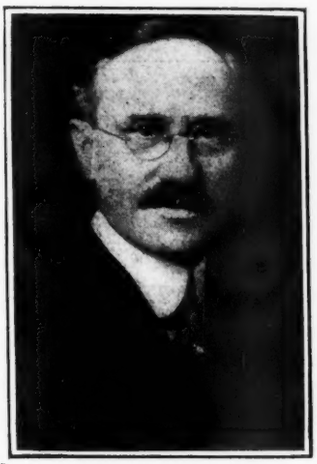
Labor, Machinery and Power Affect Production Volume

The volume of production, according to a chart prepared by the National Industrial Conference Board, Inc., during the last quarter century (1899 to 1923) has increased 185 per cent, while the number of wage earners during that time has increased only 90 per cent; "installed primary power" going into the productive process, during the same period increased 236 per cent. The increased use of machinery, however, does not tell the entire story, for, according to the chart, "installed primary power" and labor employed both dropped off in proportion to the volume of production since the year 1914. This, in the view of the Conference Board, indicates that administrative and technical improvements in the utilization of both labor and power are playing an increasingly important part in the growth of production.

E. C. Fisher of Wickes Boiler Co., Dies Suddenly

Elbert C. Fisher, vice-president of the Wickes Boiler Co., Saginaw, Mich., and well-known boiler code authority, died suddenly on May 18. He was born in Scranton, Pa., in 1865. He prepared for college in the School of Lackawanna, Scranton, and graduated from Cornell University with the degree of M. E. in 1890.

For one year he worked in the locomotive repair shop of the Delaware, Lackawanna & Western Railroad in Scranton and then went for a year to Westinghouse Church Kerr & Co., in Chicago. Then for four years he was manager of the Murphy Iron Works in the Chicago office. In 1895 he became associated with the Wickes Brothers and was made vice-president and general manager of the Wickes Boiler Co. in 1908, a position which he held until his death.



Elbert C. Fisher

Mr. Fisher was a prominent member of the A.S.M.E. Boiler Code Committee, having served continuously since 1914. He was also a member of the Board of Boiler Rules of the State of Michigan and was on the executive committee of the American Boiler Manufacturers' Association.

The news of his death comes as a shock to his many friends and associates in the power-plant field.

Joint Engineering Board Studies Ice Problems

One of the important studies which the St. Lawrence Engineering Board is undertaking deals with the ice problem. The examinations of materials now in progress will include reports on bottom and bank materials at points where it may be found advisable to slacken the velocity so as to make it possible for the ice cover to form. This can be accomplished at various points by widening the channel if the operation is faced with no unusual difficulties. On account of low banks at several points it would be impossible to accomplish the result by raising the water.

One of the difficulties of operating hydro plants in regions where low temperatures prevail is the formation of frazil ice in mushy form, which is drawn under surface ice and forms hanging dams. This causes flooding above and diminishes the power capacity below.

A meeting of the Engineering Board probably will be convened early in June to consider such revision of the season's program as may be found advisable.

Railway Fuel Association Holds Convention

The International Railway Fuel Association will hold its seventeenth annual convention at the Hotel Sherman, Chicago, Ill., May 26-29. An elaborate program comprising a schedule of thirty-one numbers and extending through seven sessions is arranged and many prominent speakers will take part in the discussions. Among those who will deliver addresses are L. F. Loree, president of the Delaware & Hudson Co.; J. D. Battle, traffic manager of the National Coal Association; P. E. Bast, fuel engineer, Delaware & Hudson Co., and Mark Kuehn, chairman of the fuel committee, National Association of Purchasing Agents.

Chicago A.S.M.E. Welcomes President Durand

At the last meeting of the season held on May 13, at the City Club, the Chicago Section of the A.S.M.E. had the pleasure of welcoming the national president of the society, Dr. W. F. Durand, and listening to his interesting address on "Engineering—Its Antiquities and Its Obligations." After reviewing various developments from their origin, Dr. Durand reminded the engineers that as they had received the inheritance of thousands of years, it was their obligation to pass it on to posterity and add to it an increment commensurate with the age in which they lived. The president's address was preceded by a talk on "The Importance of the Supplemental," by Dr. L. C. Monin, Dean of Armour Institute of Technology, that was much appreciated. If the engineer is to develop personality and become a factor in world affairs, he must divide his activities in the proper ratio among fundamentals, supplementals and incidentals; the first meaning his engineering work, the supplemental meaning art, travel, literature, civic and national affairs, and the incidental meaning pleasures and recreation. What percentage of time will be devoted to each of the three divisions will depend on the individual and his opportunities. Instead of giving 90 per cent of his time to fundamentals, the engineer must reapportion his schedule and broaden out into a well-balanced individual.

With the close of the season the following officers were elected for the ensuing year: George E. Pfisterer, chairman; Hugo Diemer, vice-chairman; F. B. Orr, secretary-treasurer; Julius Hecht, H. E. Troutman, Thomas Wilson and W. R. Chambers, executive committee.

West Penn Starts Work on Cheat Haven

Work has been started by the West Penn Power Co., according to press reports, on a hydro-electric plant at Cheat Haven, near the Pennsylvania-Ohio state line. The project, which will be completed late in 1926, will cost approximately $4,000,000.

Niagara Diversion Increase Desired

The Canadian government probably will be asked in the near future if it is ready to consider an increase in the diversion at Niagara Falls for power purposes. Action in this matter cannot be delayed greatly without permanent injury to the falls. Erosion is proceeding so rapidly that the scenic beauty of the cataract is threatened and in fact already is being impaired each year.

The principal step that can be taken to reduce the erosion is to reduce the amount of water going over the falls. The full scenic effect is secured with much less than the present minimum flow. By increasing the diversion for power-generating purposes the volume of water passing over the brink of the falls would be less and erosion would be reduced greatly.

Under the existing treaty the diversion is 56,000 cu.ft. per second. The exhaustive and carefully prepared report by Colonel Warren established to the satisfaction of most engineers that the diversion could be increased to 80,000 sec.-ft. without detracting from the beauty of the falls.

Were the scenic value of the falls not jeopardized, Canada hardly would consent to open up the diversion question at this time. Additional power is not needed in Canada, and it is recognized in the Dominion that when the proportions again are agreed upon Canada hardly can expect to be treated as generously as when the power was apportioned before.

It is assumed that some sort of joint board will be set up to discuss the problem, which will include remedial measures other than the reduction of the volume of water going over the falls.

Tennessee River Licenses Desired

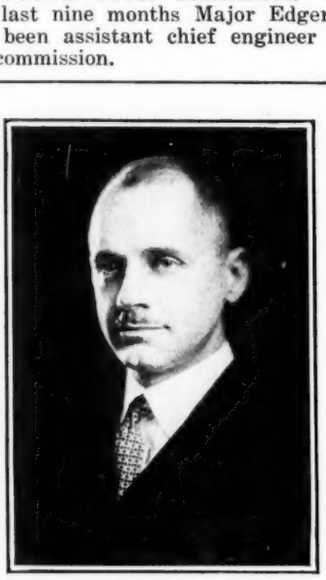
Applications for licenses covering two sites on the Tennessee River below Muscle Shoals have been filed with the Federal Power Commission. The Mississippi Power Co. proposes to build a dam 55 ft. high and approximately one mile long in the Tennessee River at Parkers Landing, near Iuka, Miss. The Muscle Shoals Hydro-Electric Co. proposes to construct a 50-ft. dam across the Tennessee at Riverton, Ala. This dam would be just below the mouth of the government canal at Colbert Shoals. Both companies are associated with the Alabama Power Company.

The two sites are ten miles apart. The Iuka dam would create 66,000 hp. of primary power. An initial installation of 100,000 hp. is proposed. At Colbert Shoals the primary power is estimated at 60,000 hp., while 90,000 hp. would be installed at that point.

The power from these two sites will be needed for public-utility use in Mississippi and western Tennessee, including Memphis, even if all the power at Muscle Shoals should be made available for distribution, a representative of the companies has advised the Power Commission. It also is stated that the applicants are prepared to begin construction work immediately as they already have acquired the necessary riparian rights and have made the preliminary engineering studies. The two projects call for the ultimate expenditure of $22,000,000. The applicants state that they are in a position to show their financial ability to undertake the projects.

Maj. Edgerton To Be Engineer for Power Commission

Maj. Glenn E. Edgerton is to succeed Col. William Kelly as chief engineer of the Federal Power Commission. For the last nine months Major Edgerton has been assistant chief engineer for the commission.



Maj. Glenn E. Edgerton

Major Edgerton's most important engineering work was in connection with the development of the highway system in Alaska, where he served as chief engineer for the Alaska Road Commission for five years. During the war he was in charge of the training of eight engineering regiments. Later he was division engineer for the 14th Division. After the war he was director of sales for two years, during which time he was in charge of the disposition of more than $150,000,000 of surplus property.

As a scholar Major Edgerton has attained unusual distinction. He stood at the head of the class of 1908 at the United States Military Academy and is an honor graduate of the General Staff School. Prior to entering West Point he had secured the degree of Mechanical Engineer and of Civil Engineer at the Agricultural College at Kansas.

Major Edgerton saw two years of service in the construction of the Panama Canal, was district engineer for the military area at El Paso, and was district engineer of the Jacksonville-Florida River and Harbor District.

Power Production Center in Illinois

Director George Otis Smith, of the United States Geological Survey, has contributed a paper on the distribution of power to the new quarterly journal, *Economic Geography*, published by Clark University. In this second number, which appears next month, after picturing the world distribution of energy resources, Dr. Smith mentions the centers of production of power in the United States and refers to future demands, in which connection he has figured the center of electric power generation to be in Illinois, about 50 miles southeast of Chicago.

Obituary

George Smart, managing news editor of *Iron Age* and one of the three responsible editors of that publication, died, after a week's illness, of erysipelas at his home in Forest Hills, L. I., on May 16. Mr. Smart was born sixty-one years ago at Chillicothe, Ohio, was educated at the Ohio State University, and spent eight years on *The Cleveland Plain Dealer*. After a year with *The Cincinnati Enquirer* he helped establish *The Columbus Citizen* which he edited for three years. From 1905 to 1917 he was editor of the *Iron Trade Review* of Cleveland, coming to the *Iron Age* in the latter year. He was prominently affiliated with numerous social and educational associations and during 1923 was chairman of the Editorial Conference of the New York Business Papers Association.

William Clark Hawkins, director, chief engineer and secretary of the Dominion Power & Transmission Co., Ltd., died suddenly on May 11, while on a fishing trip. Mr. Hawkins was born in Orange, N. J., in 1866, was educated at the grammar and high schools of Taunton, Mass., and received his degree of M. E. at Stevens Institute of Technology in Hoboken, N. J. He had been connected with the Third Avenue Cable Co., New York City, Plymouth Electrical Light Co., Plymouth, Mass., Concord Land & Water Power Co., Concord, N. H., Columbia Water Power Co., Columbia, N. C., finally going to Schenectady, where he worked with companies in the planning of institutions and ,acted as expert fireman in instructing firemen in the firing of boilers, etc. In 1901 he went to Canada as secretary and manager of the Hamilton Light & Cataract Power Co., and later was made managing director and chief engineer of the Dominion Power & Transmission Co. He was a member of many societies and clubs, including the A.S.M.E. and the A.I.E.E.

David Barnes Morison, for many years managing director and chairman, Messrs. Richardsons, Westgarth & Co., Ltd., Hartlepool, Eng., died on April 23 at Nice at the age of 66. Mr. Morison was born in Devonshire and was educated at the Ashburton Grammar School.

On leaving this school, he entered the works of John Elder & Co. as an apprentice during which time he at-

tended the technical classes of the Andersonian College, now known as the Royal Technical College. After some experience at sea, he entered the employ of T. Richardsons & Sons, and became general manager of the company at the age of 28. Under his management the Hartlepool engine works were modernized. He was responsible for the design of many novel engine accessories, making designs for heat accumulators, jet air pumps for condensers, the improvement of the condenser, and other designs for the reciprocating engines, and later with steam turbines. His suspension furnace has been largely adapted in marine boilers. He was a firm believer in research and in the need for improvement of the operating engineer's status. He was active in promoting the tests for marine oil engines now being carried out under the auspices of the Institution of Mechanical Engineers. He was a member of many scientific and engineering societies and was on the Councils of the Institute of Naval Architects and the Institution of Mechanical Engineers.

Business Notes

The McGraw-Hill Co., Inc., 10th Ave. at 36th St., New York City, announces that its Chicago office is now located at 7 South Dearborn St.

Chas. Cory & Sons, Inc., 183 Varick St., New York City, announce that Arthur D. Blanchard has been transferred from the engineering department to the industrial sales staff.

The Boston Woven Hose & Rubber Co., Cambridge, Mass., announces the appointment of Arthur C. Kingston as director of sales of the company following the resignation of Edgar E. Fay, who had been in charge of sales for twenty-five years.

The Standard Turbine Corp., Scio, N. Y., announces the appointment of: The Hale-Stephan Co., 7016 Euclid Ave., Cleveland, Ohio, as its representative for the Cleveland district; Edward P. Johnson, 841 David-Whitney Bldg., Detroit, Mich. for the Detroit district.

The Bridgeport Brass Co., Bridgeport, Conn., announces that it has another edition of its "Ledrite Rod-o-Graphs," a chart for figuring the weight of brass rod required to make 1,000 screw machine parts of known dimensions, and will be glad to send a copy to anyone requesting it.

The Link-Belt Co., 910 S. Michigan Ave., Chicago, announces that it has standardized its silent chain drives, which have hitherto been sold only on a made-to-order basis and that it is now possible to obtain from the stock of the nearest distributor these drives from one to ten horsepower.

The Sullivan Machinery Co., Chicago, Ill., announces that the office at Dallas, Texas, has been removed from the Western Indemnity Bldg. to the Santa Fe Bldg. with David H. Hunter as manager; the appointment of Earl E. Miller as manager of its El Paso (Texas) branch, succeeding R. S. Weiner, who is transferred to the Chicago office.

Coming Conventions

American Association for the Advancement of Science, Burton E. Livingston, Smithsonian Bldg., Washington, D. C. Eightieth annual meeting at Portland, Ore., June 17-20.

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Convention at Orlando, Fla., June 2-5.

American Boiler Mfg. Association, H. N. Covell, 7 East 19th Ave., Brooklyn, N. Y. Meeting at Glen Spring Hotel, Watkins, N. Y., June 1-3.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, Chalfonte-Haddon Hall, June 22-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at Saratoga Springs, June 22-26. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Semi-annual meeting at Traymore Hotel, Atlantic City, June 15-17.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Portland, Ore., June 22-25.

Canadian Association of Stationary Engineers. R. M. McLaren, Pres., 160 Dovercourt Rd., Toronto, Ont. Convention at Windsor, June 29-July 1.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Illinois Association at Decatur.** Olaf Jacobsen, 837 Lake Side Place, Chicago. June 3-5. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at McAlpin Hotel, New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **Iowa State Association** at Ottumwa, June 16-18. F. L. Stocker, 127 S. Elm St., Ottumwa, Iowa. **New England States Association** at Worcester, Mass., July 9-11, formerly announced July 10-12. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association** at Muskegon, July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

Smoke Prevention Association—Frank A. Chambers, 1411 City Hall Sq. Bldg., Chicago, Ill. Nineteenth annual convention at Hotel Pantlind, Grand Rapids, Mich., June 17-20.

Society of Automotive Engineers, Inc. C. F. Clarkson, 29 West 39th St., New York City. Convention at Greenbrier Hotel, White Sulphur Springs, June 15-19.

Society for the Promotion of Engineering Education. F. L. Bishop, University of Pittsburgh, Pa. Meeting at Union College, Schenectady, N. Y., June 17-20.

Trade Catalogs

Cleaners—Liberty Manufacturing Co., Frick Bldg., Pittsburgh, Pa. Catalog, "Liberty Cleaners for Removing Incrustation from Boilers, Tubular Apparatus and Pipes," contains pictures and descriptions of these cleaners and methods of using them for the various purposes for which they are designed.

Heat Regulation — The Fulton Co., Knoxville, Tenn. "Sylphon Regitherm" is the title of Bulletin R-102 describing an instrument for automatically controlling air temperatures. Reproductions of blueprint drawings of installations and photos add to the interest of the publication.

Filtration—International Filter Co., water-softening and filtration plants, 333 West 25th Place, Chicago, Ill. "How a Water Analysis Tells the Quality of Ice You Make," is the title of Bulletin No. 2002, recently published by the company, which discusses the effect of impurities in water on the quality of ice made from it.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack (*Coal Age*):

Bituminous, Net Tons	Market Quoting	May 18, 1925
Pool 1	New York	$2.40@$2.70
Smokeless	Boston	1.54
Clearfield	Boston	1.70@ 2.00
Somerset	Boston	1.85@ 2.10
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.35@ 1.50
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.15@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$2.60
Buckwheat No. 1.	Philadelphia	2.25@ 2.75
Birdseye	New York	1.40@ 1.60

FUEL OIL

New York—May 21, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal.; 36@40 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis — May 20, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.70 per bbl.; 26@28 deg., $1.75 per bbl.; 28@30 deg., $1.80 per bbl.; 30@32 deg., $1.85 per bbl.; 32@ 36 deg., gas oil, 4¾c. per gal.; 38@40 deg., 5½c. per gal.

Pittsburgh—May 18, f.o.b. local refinery; 30@34 deg. fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.

Dallas—May 13, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

Philadelphia — May 14, 28@30 deg., $2.21@$2.273 per bbl.; 18@22 deg., $1.90@$1.963; 13@16 deg., $1.785@ $1.85 per bbl.

Boston—May 18, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4½c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati — May 19, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

New Plant Construction

Ala., Mobile — U. S. Treasury Dept., Washington, D. C., J. A. Wetmore, Acting Supervising Archt., will receive bids until June 16th for a hot water heating plant for Marine Hospital, here.

Ark., Newark—City is organizing district to provide funds for the installation of oil engine electric light plant. Estimated cost $25,000. E. H. Glenn, Baresville, is engineer.

Calif., Los Angeles — Winter Palace Amusement Corporation, W. H. Dillehunt, 709 Commercial Exchange Bldg., is having plans prepared for the construction of a 140 x 310 ft. ice skating arena at Vermont St. and Beverly Blvd. Estimated cost $250,000. C. R. Selkirk, 800 American Bank Bldg., is architect.

D. C., Washington—H. A. Flint, Gen. Pur. Officer for Panama Canal, will receive bids until June 8th for supplies, including transformers, etc. (Spec. 1671)

D. C., Washington—U. S. Navy, Central Sales Office, Navy Yard, Officer-in-Charge will take bids until June 4, for 6 hp. gas engine; d.c. and a.c. generators belt driven; shafting, belts, etc.

Fla., Clewiston—Sugarlands Drainage Dist., Glades and Hendry Counties, F. D. Duff, Secy., will receive bids until June 16th, for the construction of a complete oil engine driven drainage pumping plant, 180,000 g.p.m. against a head of 6 ft. Elliott & Harmon Engineering Co., Bank Commercial Block, Memphis, Tenn., are engineers.

Fla., Okeechobee—Mayor and City Council, R. P. Fletcher, Clk., will receive bids until June 8, for the construction of 1 m.g.d. filtration plant and pumping station, etc. Equipment includes two 1,000 g.p.m. intake pumps and motors, or other drive, starting and controlling equipment; one 750 g.p.m. and one 350 g.p.m. service pump and motor, etc. F. E. Lawrence is engineer.

Fla., Panama City—Econfina Power Co., W. P. Sherman, Pres., recently incorporated, $500,000, plans the construction of a hydro-electric plant on Econfina Creek.

Ga., Brunswick—U. S. Treasury Dept., Washington, D. C., J. A. Wetmore, acting Supervising Archt., will receive bids until June 16th for an electric light plant, etc., here.

Ga., Fayetteville—City Council and E. C. Seawright, Mayor, will receive bids until June 1st, for the construction of an electric light and waterworks plant. Equipment including 50 g.p.m. deep well pump, 7½ hp. motor, 100 hp. oil engine, 75 kw. generator, pump house, etc., will be purchased direct by owner. J. B. McCray Engineering Co., Citizens & South Bank Bldg., Atlanta, is engineer.

Ga., Jackson—Pepperton Cotton Mills, plans the construction of a new steam plant for its mill. Lockwood, Greene & Co., Healey Bldg., Atlanta, are engineers.

Ga., Savannah—L. P. Hart, 203 East Gwinnett St., plans the construction of a cold storage and ice plant.

Ill., Carthage—City will take bids until June 3rd., for pumping equipment, tank on tower, etc. Estimated cost $150,000. Caldwell Engineering Co., Jacksonville, is engineer.

Ill., Rockford—Manufacturers National Bank, 327 East State St., awarded contract for the construction of an 8 story bank and office building to Holm-Page Co., Kishwaukee St. Estimated cost $500,000. Peterson & Johnson, Swedish-American Bank Bldg., Archts., will receive bids for heating, elevators, etc.

Ky., Louisville—U. S. Engineers Office, E. Kanzler, Pur. Agt., will soon receive bids for 6 x 3½ x 6 in. horizontal duplex, outside end packed plunger, pot valve boiler feed or pressure pump for 300 lb. pressure., for steamer Margaret.

Ky., Murray — City, C. B. Crawford, Supt., is in the market for 200 hp. Diesel oil engine generator unit, with accessories.

La., Bossier City—Town Council awarded contract for the construction of waterworks, system, pumping station, etc., to the James Construction Co., Shreveport, $137,840.

La., New Orleans—U. S. Treasury Dept., Washington, D. C., J. A. Wetmore, acting Supervising Archt., will receive bids until June 17th for a heating system in U. S. Marine Hospital, here.

La., Youngsville—G. Parent, Mayor and Bd. of Aldermen, will soon award contract for the construction of waterworks and electric light systems.

Md., Baltimore—Gold Dust Corporation, awarded contract for the construction of a group of buildings, including boiler house, engine room, etc., to Consolidated Engineering Co., Calvert Bldg., Lockwood, Greene & Co., 1 Pershing Sq., New York, are engineers.

Md., Baltimore—A. Weiskittel & Sons Co., Lombard and 12th Sts., plans the construction of part of plant including a boiler and engine room, foundries, etc., to replace fire loss. Estimated cost $200,000.

Mich., Detroit—L. Chesnow, 705 Lincoln Bldg., Archt., is receiving bids for the construction of a 9 story hotel, including steam heating system at East Jefferson Ave., for L. Gorelick, 600 Woodland Ave.

Mich., Sault. Ste. Marie—Edison Sault Electric Co., 115 Ashmun St., T. Chandler, Pres., will receive bids until June 5 for deepening of headrace of government power plant.

Minn., Moorhead—City plans an election soon to vote $50,000 bonds for improvements to water and light plant. Former proposal to vote $135,000 for new plant defeated.

Neb., Schuyler—City, G. F. McKenzie, Clk., City Hall, is receiving bids for 200 to 250 hp. water tube boiler; three 8 in. Herringbone grates, shaking grates for boilers, force draft under feed stoker with automatic control; 200 hp. superheater for boiler, etc.

N. Y., Geneva—C. D. Bostwick, Comptroller, Morrill Hall, Cornell University, Ithaca, will receive bids until June 17 for heating system including new boilers, etc., for the Geneva Experimental Station, here. S. W. Jones, Capitol, Albany, is state architect.

N. Y., New York—E. Ellinger, 21 East 40th St., awarded contract for the construction of a 15 story apartment hotel at 56-60 East 40th St. to L. K. Comstock Engineering Co., 21 East 40th St.

N. Y., New York—The Garment Workers' Union, M. Sigman, Pres., 3 West 16th St., will receive bids about June 1st for the construction of a 5 story apartment including steam heating system, at 158th St. and Sheridan Ave. Estimated cost $1,500,000. A. J. Thomas, 15 East 47th St., is architect.

N. Y., New York—New York State Bridge and Tunnel Comm., G. R. Dyer, Chrn., and New Jersey Interstate Bridge and Tunnel Comm., T. Boettger, Chrn., 3004 Woolworth Bldg., will receive bids until July 7th, for eighteen 1,000 kva. air blast transformers, switches, etc., for use in the ventilation buildings of the Holland Tunnel (Contract 9).

O., Barberton—Lambert Tire Co., G. Collette, plans the construction of a boiler house and power plant. Estimated cost $125,000.

Okla., Carter—City, G. C. Mitchell, Clk., will take bids until June 5th for the construction of step down station, electric distribution system, transmission lines, etc. Estimated cost $25,000. V. V. Long & Co., Colcord Block, Oklahoma City, is engineer.

Okla., Comanche—City, L. C. Randel, Clk., is having preliminary plans prepared for improvements to water plant including motor driven pumps, etc. Estimated cost $30,000. Engineer not selected.

Okla., Grandfield—City, G. H. Hoefer, Mgr., is in the market for 2 motor driven pumps of 200 g.p.m. capacity against 300 ft. head, each 30 hp.

Okla., Healdton—City is having preliminary plans prepared for the construction of 2 deep wells, storage reservoir, mains, etc., including deep well, double stroke pumps. Estimated cost $20,000. C. Coon, 1520 North Broadway, Oklahoma City, is engineer.

Okla., Henryetta—City, J. W. Orendorff, Mayor, plans an addition to filter plant, new reservoir pumping equipment, etc. Estimated cost $75,000. Holway Engineering Co., Wright Bldg., Tulsa, is consulting engineer.

Okla., Okeene—City, S. P. Fox, Clk., plans extensions to distribution system, including deep well motor driven, triplex pump, etc. Estimated cost $18,000. V. V. Long & Co., Colcord Block, Oklahoma City, is engineer.

Okla., Oklahoma City—New State Ice Co., 2 West Third St., will build a 30 ton raw water ice plant in northern part of city. Work to be done by company forces. Estimated cost $60,000. C. Gletch, 114 East 7th St., is engineer.

Okla., Pauls Valley—City, R. E. Braden, Supt. waterworks, is in the market for 2 double stroke deep well pumps, 80 g.p.m. capacity each, equipped with 125 hp. motors.

Pa., Philadelphia—Dept. of Public Works, Bureau of Water, G. H. Biles, Dir. Room 216, City Hall, will receive bids until June 1st for power equipment for the Queens Lane Extension, including generating and pumping equipment, boilers, transmission lines, with accessories and appurtenances, etc.

R. I., Providence—Narragansett Electric Lighting Co., is receiving bids for the construction of a 4 story switch house extention on Eddy St. Jenks & Ballou, 10 Weybossett St., are engineers.

S. D., Huron—Lampe Meat Market, plans the construction of a 3 story meat market, including refrigerating plant. Estimated cost $125,000. C. A. Berger, 401 Phoenix Bldg., is engineer. Refrigerating machinery will be purchased.

S. D., Pierre — Capitol Commission, J. Erickson, Asst. Supt., will receive bids until June 2nd for the construction of a pump house and installation of auxiliary equipment, including fire pump, etc., at state capitol.

S. D., Rapid City—Rapid City Packing Co., E. E. Hill, Gen. Mgr., awarded contract for the construction of a 3 story packing plant unit, including refrigeration system, etc., to H. Carlson Co., 1119 South 3rd Ave., Sioux Falls. $33,000.

Tex., Bay City—City, P. Thompson, Mayor, plans an election soon to vote $50,000 bonds for waterworks improvements, including pumping equipment, etc. Terrell Bartlett, Engineers, 612 Calcasieu Bldg., San Antonio, are engineers.

Tex., Big Springs—City, J. W. Middleton, Secy., is having preliminary plans prepared for the construction of water works extensions, including additional pumping equipment, etc. Montgomery & Ward, Wichita Falls, are engineers.

Tex., Dilley—City, R. Busby, Mayor, will receive bids until June 4th, for the construction of distribution system and other improvements. Equipment includes 50 cu.ft. per min. air compressor and motor; centrifugal or turbine well pump and motor; 100 g.p.m. service pump and d.c. motor, tank on tower, etc. Estimated cost $30,000. Terrell Bartlett Engineers, 612 Calcasieu Bldg., San Antonio, are engineers.

Tex., Nordheim—City plans the construction of waterworks improvements, including pumping equipment, etc. Estimated cost $30,000. Terrell Bartlett Engineers, 612 Calcasieu Bldg., San Antonio, are engineers.

Tex., Ranger—City, J. Galloway, Comr., is in the market for a 90 hp. marine engine driven, centrifugal fire pump.

Tex., Temple — Local Syndicate, c/o Chamber of Commerce, plans the construction of a 100 ton daily capacity ice plant. Machinery will be required. Estimated cost $150,000.

Tex., Thrall—Thrall Gin Co. is having plans prepared for improvements to present gin plant including 250 hp. engine, boiler, machinery, etc. Private plans.

Tex., Victoria—Hill-O'Connor will soon award contract for the construction of a 73 x 160 ft. cold storage plant. M. L. Diver, Calcasieu Bldg., San Antonio, is engineer.

Wis., Burkhardt—Willow River Power Co., A. R. Schultz, Pres., Hudson, plans the construction of a dam and hydro electric plant on Willow River. Estimated cost $50,000. Engineer not selected.

Wis., Watertown—Watertown Milk Producers' Association, Route 2, awarded contract for the construction of a 60 x 82 ft. manufacturing building, 32 x 40 ft. boiler house, etc., to Watertown Construction Co., 712 West Main St.

Ont., Crystal Beach—P. E. Ryan, will receive bids until May 29th, for the construction of waterworks system, intake, crib pumping station, pressure filters, with 750,000 gal. capacity, pumps, etc. E. H. Darling, 47 Home Bank Bldg., Hamilton is engineer